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**IRRIGATION SECTOR REVIEW**

**Volume I - Main Report**

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Agriculture Operations Division  
India Department  
India Region

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INDIAIRRIGATION SECTOR REVIEWAbbreviations

AD	Agricultural Department
CADA	Command Area Development Authority
CBIP	Central Board of Irrigation and Power
CGWB	Central Groundwater Board
CWC	Central Water Commission
GOI	Government of India
ID	Irrigation Department
MIS	Management Information System
MOF	Ministry of Finance
MOWR	Ministry of Water Resources
NABARD	National Bank for Agriculture and Rural Development
NWMP	National Water Management Project
O&M	Operations and Maintenance
PCR	Project Completion Report
R&R	Resettlement and Rehabilitation
WALMI	Water and Land Management Institute
WUA	Water User's Association

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Measure: 1 hectare (ha) = 2.47 acres

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INDIA  
IRRIGATION SECTOR REVIEW

Volume I - Main Report

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## EXECUTIVE SUMMARY

i. In many respects Indian irrigation is at a crossroads. The choices are continuation of the status quo and a modest, possibly diminishing agricultural growth rate, or concerted reform and renewal in the interest of matching reality to potential. The reality is that one of the world's largest irrigation investments is performing unevenly and, on average, far below potential. The yield gap is apparent within India -- between the best-performing areas and those weighing down average yields -- and between India and other Asian countries. Cropping intensity also falls far short of performance in comparable settings in Asia and elsewhere. Despite several decades of significant public investment in irrigation infrastructure, mainly large surface schemes, productivity is not breaking through to enable agricultural growth beyond the past threshold of 2.5% per annum.

ii. India will be critically dependent on better performance from irrigation. Over 55% of agricultural output is from irrigated lands, and production elsewhere is constrained by lack of land for expansion and the risks and limitations prevalent under rainfed conditions. The pricing environment, other rural infrastructure and rural services are also fundamental to agricultural growth, but the resolution of water constraints enabled by irrigation is a springboard for productive capability. Where irrigation has been successful in India, notably in the northwest, it has had wide-reaching impact on both agricultural and general welfare and development. By contrast, the commoner situation of weakly performing irrigation has not allowed rural development potential to be realized.

iii. The findings of this review point to poor sector planning and financial management, on one hand, and inadequate water management and maintenance, on the other, as the main causes of mediocre performance. Paradoxically, India's major engineering achievements over the past half-century, resulting in massive expansion of surface irrigation, have contributed to the sector's current problems. With the focus centered on construction, the broader management needs of the sector were neglected, and the cumulative costs of this neglect are now apparent. Over the past decade, the situation appears to have worsened: lack of financial discipline and accountability, neglected maintenance, and construction abuses have become endemic. Also, rapidly rising recurrent expenditure on unproductive staff costs is squeezing out genuine investment in the sector and, combined with inadequate pricing of water and electricity, is throwing the sector into financial crisis. India cannot afford an over-expensed and under-performing sector. Sooner, rather than later, the burden will be financially unsustainable, and infrastructure will be physically unsustainable due to declining construction and maintenance standards. The situation is compounded in some areas by environmental degradation. Above all, agricultural growth will suffer.

iv. The role of management in creating as well as disentangling the knot of diagnosed problems in this review is clear. Much of the current sectoral malaise stems from the fact that irrigation is largely managed by government monopoly, that a culture of "government needs to do it" prevails, and that the sector's bureaucracy has grown unwieldy, not adaptive to changing needs, with narrow engineering interests and lacking training and incentives to improve performance.

v. The most fundamental order of business is for government at both state and central levels to reassess its monopoly and to scrutinize its role vis à vis the private sector, whose tremendous energies and capital -- both human and financial -- have barely been harnessed. Where appropriate, and opportunities abound, government should begin to divest as much implementation and investment as possible to the private sector.

vi. Simultaneously, government should evaluate its own performance, implement improvements in critically deficient functions, and ascribe new roles as necessary to state and central institutions. This stock-taking exercise can serve the useful purpose of charting a course for remediation and development and identifying short- and medium-term steps to take in getting there.

vii. Major effort is required in four areas that are the focus of this sector review: (i) forging a coherent water policy, (ii) prioritizing investment and getting control of expenditure, (iii) improving productivity and ensuring sustainability, and (iv) building critical capacity within the public and private sectors in order to manage the sector more efficiently and effectively.

viii. Water Policy and Planning. The present situation whereby planning of water development is handled on a state-by-state basis skirts a primary requirement: that planning and coordination of water use occur on a holistic basis, centered on the natural hydrological unit, the river basin. Only one of India's 18 major river basins is within the confines of a single state. Further, demands for water -- whether for agricultural, municipal or industrial use -- are growing, and interests between different users and states are increasingly colliding. Data collection is also disparate and provides an inadequate basis for water planning. The magnitude of India's water resources, how they should be best deployed, to what areas, for what uses, are critical questions that deserve considered answers beyond the confines of state boundaries. These problems heighten the need for application of India's National Water Policy, initiated in 1987 but with little operational follow-up. The states should ratify the national water policy and develop state water policies fitting within the context of this document; river basin planning commissions should be established to plan and develop water resources on a holistic basis; and consideration should be given to additional legislative or constitutional actions to coordinate water development respecting national and inter-state interests.

ix. Investment Focus and Financial Management. Efficient use of scarce public resources must govern future investment choice and expenditure. Well-conceived investment priorities and quality project preparation are essential. The investment focus for irrigation should shift toward actions that have high economic viability, near-term impact and relatively low per-hectare cost, and to those that support investment by the private sector. Past investment in high-cost construction of new surface schemes has led to a substantial backlog of incomplete works that have absorbed funds and managerial effort to the detriment of more viable options and maintenance of existing schemes. Investment in new construction should be restricted to the few cases where regional development is dependent on the supply of additional water.

x. In nearly all states, the development agenda through at least a decade should concentrate on improving the performance of existing irrigation, complemented by selective viable expansion. Achieving better performance demands that major attention be given to maintenance and to improving water management. Maintenance should have the first call on public expenditure -- preserving existing infrastructure is paramount -- followed by concerted effort and resource allocation to improve water management. Expansion, for the public sector, should involve completion of ongoing projects, with low remaining costs and rapid maturity, selected on the basis of clearcut viability, available water and sound technical preparation. Another opportunity is surface drainage, widely neglected in the past, in areas subject to monsoon waterlogging. Rehabilitation of failed infrastructure, and in some areas, selective investment in flood control, drainage to combat rising groundwater tables, and rehabilitation of saline lands are also needed.

xi. While public investment in irrigation is the focus of this review, two important investments should be divested to the private sector: groundwater and farm-level watercourses. Groundwater development, having the largest impact in recent decades both on expansion and productivity, should remain in the hands of farmers. Existing public tubewell development programs, which have not been effective, should be halted, and existing wells turned over to farmers or entrepreneurs. The public sector's role should be to foster private investment: provision of credit, research and extension, monitoring of groundwater levels and planning of surface irrigation for conjunctive use and groundwater recharge. Farm-level watercourses, field channels and field drains (micronetworks) should be constructed and maintained by farmers. Government implementation, which has been costly and with limited impact, should be replaced by technical

assistance and credit to farmers.

xii. Soaring recurrent expenditures -- increasing nearly threefold in real terms over the past decade -- must be curbed through halting the recruitment of staff and tightening financial controls against leakages. Steps must also be taken to bolster cost-recovery in the sector; water and electricity rates should be treated as utility fees with rates governed by O&M costs at minimum. To stimulate action and achieve accountability, water charges should be reassessed by state governments and cost-recovery performance evaluated annually in public reports. Collection should be simplified and handed over to local communities, retaining a percentage as incentive. As users take over scheme management, revenues collected should be retained. Electricity subsidies for well irrigation should be removed and a plan prepared for transition to meter-based pricing.

xiii. The skills that imbue financial discipline -- cost accounting, monitoring, financial and economic analysis, and business planning capabilities -- are sorely lacking in both state and central institutions. These skills should be implanted as quickly as possible, whether through training programs or recruitment of consultants.

xiv. Accountability and transparency of the funding and expenditure process are critical requirements. Getting there will require state and central governments to monitor more carefully financial management by state irrigation departments, based on annual analysis of expenditure, detailed planning and budgeting of maintenance and reporting of cost recovery status. Disbursement of central funds for state irrigation programs should be conditional on adequate financial and cost recovery reporting, control of recurrent expenditures, and full funding of maintenance.

xv. Technical Performance. Improving water management should become the principal technical preoccupation of irrigation managers. Deficiencies are widespread, with some 10-13 million hectares of surface irrigation performing well below potential and some improvement possible on most of the remaining area. Pilot efforts, including the National Water Management Project (Cr. 1770), are in their early stages but indicate the directions to take. The dimensions of the problem require a low-cost, replicable approach with emphasis on diagnostics of problems and improvement possibilities at the level of each command, followed by development, in consultation with farmers, of a seasonal plan of command operation, complementary investment in low-cost infrastructure to achieve better water control, and upgraded daily management and monitoring. The existing pilot efforts should be expanded, necessitating funding for this purpose, reallocation of management efforts, staff and training to this function, and use of consultants to augment current capabilities. Technological research should support this drive, also to be accompanied by piloting of innovations on selected commands to achieve higher productivity.

xvi. Environmental and resettlement and rehabilitation needs have been neglected. National policy papers should be prepared on both issues to forge consensus and guide implementation. Earlier government environmental assessments are needed to influence project design, and environmental monitoring needs to be enhanced. Successful pilot resettlement and rehabilitation schemes now need to be generalized across all projects, the key being detailed preparation, full funding as part of project costs, and early establishment of institutional capability.

xvii. The technical skills for quality maintenance and construction are generally well known. The deleterious element is inadequate control of quality due to lax supervision and monitoring exacerbated by corruptive influences. Much tighter management of maintenance and construction is required but resolution goes beyond the orbit of the supervising engineer and will require commitment and backing from senior state authorities.

xviii. Private/Government Roles and Capacity. The greatest challenge is in the management domain, the source of most of the sector's problems due to weak capacity, increasingly

overwhelmed by the growing complexity of the sector in the face of limited institutional adaptation and encroachment of rent-seeking and often disruptive political pressures. State-level improvement will have greatest influence, particularly within the irrigation department, the principal implementing agency. Numerous measures are available to improve irrigation department management: creation of a corporate management culture and integration of non-engineering skills; organizational restructuring along functional lines (e.g., maintenance, water management monitoring, project preparation and design); aggressive training and use of consultants to upgrade expertise; and reporting procedures to increase public accountability. The goal should be to shift irrigation department managements from a narrow engineering focus to a managerial one that permeates all functions and levels. Clarification of roles and better coordination with other departments involved with irrigation are also required.

xix. Parallel steps are needed toward progressive divestiture, where feasible, of functions and implementation to the private sector. Short-term opportunities are available. The resources of universities, research centers, NGOs and consultants can be used to enhance implementation capacity, research and training. Maintenance can be contracted to the private sector rather than implemented by government as commonly done. Government functions at the local level (junior water management staff, water charge collectors) can be fulfilled by water-user associations or panchayats, and public functions eliminated.

xx. For the longer term, actions should be charted now to create autonomous commands. Commands will only achieve financial discipline over maintenance and operating costs and become responsive to user needs if they are financially independent and managed by users. A major thrust is required to help establish water-user associations, to move farmer responsibility progressively to higher levels of command management, to create independent entities (e.g., registered societies), and eventually to hand over functional control to farmers, with water charges retained by the command. Suitable commands for initiating this approach are to be found in most states.

xxi. Immediate Action. Over the next 12 months, the states should execute the following activities on the path to a clearer investment focus, fiscal responsibility and improved productivity and sustainability of the sector:

- o Re-examine expenditure focus and develop new priorities based on economic viability and impact;
- o Prepare and implement an interim action plan to halt staff growth, provide adequate maintenance funding, curb leakages and introduce cost accounting;
- o Commence annual reporting of financial expenditure and cost accounting, a maintenance plan, budget and review, and a cost recovery status report;
- o Prepare and initiate a water management improvement program;
- o Begin restructuring of irrigation departments, injecting non-engineering skills, establishing an MIS function, upgrading project preparation capabilities and funding training and consultancies;
- o Identify areas for private sector involvement;
- o Identify specific commands where management can devolve to autonomous units; and
- o Initiate an extension program to assist farmers to form water-user associations, participate in scheme management, and construct, maintain and operate micronetworks.

For its part, the central government should:

- o Strengthen its review function of irrigation planning and finance by the states, insisting on good maintenance, financial discipline and expenditure priorities;
- o Promote the national water policy and creation of river basin planning commissions;
- o Prepare national policies on environment and resettlement and rehabilitation;
- o Strengthen inter-ministerial/agency cooperation and staff capabilities focussing on water policy coordination, overview of state performance, strategic analysis, research networking and project evaluation; and
- o Identify programs for central financial support to state initiatives in priority functional areas (e.g., water management).

xxii. The need is clear. Improved irrigation performance will depend in the short term on the degree to which managerial discipline can be brought to bear on the sector at all levels: irrigation departments, state governments and at the center. Further improvement will depend on more fundamental change, recognizing that government cannot do everything, that the initiative and capital of the private sector should be tapped, and that management of completed schemes should become the administrative and financial responsibility of users. Some steps that will be necessary to lead in the prescribed direction are bold, requiring restructuring, reform, and progressive devolution; others are pedestrian, requiring more diligence and tenacity in current roles and functions. In both cases, the outcome should be improved productivity in irrigation, a critical need in India for the remainder of this century and beyond. The choices are for India's policymakers and planners to make.



## CHAPTER I. THE CHALLENGE AND STRATEGIC CHOICES

### A. Critical Issues

1.1 Agricultural performance is fundamental to India's future economic and social development. Agriculture contributes 30% of GNP, 60% of employment, and is the primary source of livelihood in rural areas which account for 75% of India's population and 80% of its poor. With all arable land under cultivation, increased agricultural output will depend on raising crop yields, increasing cropping intensity, and diversification to higher-value crops. The performance of irrigated agriculture, which contributes 55% of agricultural output, will be the most important influence on these objectives. Addressing the irrigation sector's current performance problems will thus be a central element of future strategy for agricultural development.

1.2 With the largest irrigated area in the world, Indian irrigation has much to be proud of. Its development, the product of major efforts and achievements by India's irrigation engineers and of greatly expanded government investment since Independence, has been the principal force behind agricultural growth. Its role will be indispensable to future growth. Nonetheless, due to rapid expansion of irrigation with its emphasis on new construction, the performance of irrigation and the sector's broader management needs have been neglected. The development impact of irrigation is much less than its potential and deficiencies in implementation have accumulated over time. The sector is now in crisis. Four issues are of particular concern: productivity, sustainability, investment focus and financial discipline, and sector management.

1.3 The productivity of irrigation is low and well below potential. On the majority of surface irrigation schemes, suboptimal distribution of water (timing, reliability and spatial distribution) results in low yields and cropping intensity and reduced opportunities for diversifying agriculture. Deficiencies in agricultural extension, limited research on irrigation technology, and insufficient piloting of innovations compound the situation. Poor design and project preparation of many surface irrigation schemes and deteriorating infrastructure are also having significant deleterious effect.

1.4 The sustainability of India's vast irrigation investment is in serious question, mainly due to a marked decline in maintenance of infrastructure and a similar decline in the quality of construction over the past two decades. Rehabilitation requirements are already large and threaten to dominate expenditure unless maintenance and construction are improved. Additionally, environmental problems are mounting, requiring substantial attention to them, drainage, and resettlement of displaced communities. A void in water resource planning and coordination of usage urgently needs to be filled.

1.5 The investment focus and financial discipline of irrigation require rethinking and reform. Substantial reallocation of government expenditures is required to support investment for improving productivity, adequate maintenance, completion of ongoing projects, drainage, and micronetwork and groundwater investment by farmers. Sharp financial deterioration of the sector poses a serious threat. Recurrent expenditures have ballooned in the past decade, with most of the increase going to unproductive staff growth and wastage due to lax control of expenditures and works. Cost recovery has dwindled and irrigation-related subsidies now loom large in state government budgets. These impacts are crowding out worthwhile investment.

1.6 Ineffective sector management underlies most of these deficiencies. Sector institutions, notably state irrigation departments, have undergone little change over many decades, while sectoral priorities have changed and execution has become more complex. The departments' structures, functions and approach are predominantly construction-engineering; this orientation is inadequate in face of the need for a broader management culture and sharper diagnostics and response to the sector's weaknesses and opportunities. The roles of other state institutions involved with irrigation need better definition and coordination among them. The vitality and capital of non-government sources are not being captured, and significant opportunity for greater involvement of farmers and the private sector has been virtually ignored.

1.7 If these issues are not resolved, productivity will remain low; infrastructure will progressively deteriorate, leading to declining irrigated area or insupportable rehabilitation needs; financial imbalances will continue to widen; and most seriously, there will be little scope for maintaining the agricultural growth rate.

1.8 It is clearly within the capabilities of the sector's managers and its engineering cadre to tackle the problems, as evidenced by many examples of excellent performance in Indian irrigation, even though limited in number and regionally concentrated. Major improvement is required and no state is entirely free of problems discussed in this review. The proposed strategy calls for a substantial reform of irrigation sector management, focussing on critical performance problems. Reform will only be achievable with strong consensus and commitment from senior political and government establishments at both state and central levels.

## B. Development of Irrigation

1.9 Investment in irrigation has been a development priority in India.<sup>1</sup> By 1950, 21 million hectares (ha) of land were under irrigation, mostly built during the previous 75 years, but some works dating to before the 10th century. Successive five-year plans have emphasized irrigation investment, with expansion of net irrigated area averaging 0.6 million ha per annum. Net irrigated area had doubled to 42 million ha by 1984-85. With part of this area double-cropped, gross irrigated area was about 54 million ha or nearly one third of India's gross cropped area.<sup>2</sup>

1.10 Rapid growth of irrigation since 1950 has involved both construction of new surface irrigation schemes and increase in groundwater irrigation (Table 1.1). Between 1950-51 and 1984-85, public investment in canal irrigation doubled the area under surface irrigation from 8.3 million ha to 15.9 million ha (about 220,000 ha or 1.9% per annum). Since the early 1960s, private tubewell irrigation has grown spectacularly, from almost nil to 11.3 million ha by 1984-85 (7% per annum growth between 1970-71 and 1984-85). More modest growth in the number of dugwells brought the net area irrigated by well irrigation to 20 million ha by 1984-85.

Table 1.1 Development of Irrigation: 1950 - 1985  
(Net Irrigated Area in Million Hectares)

	<u>1950-51</u>	<u>1960-61</u>	<u>1970-71</u>	<u>1980-81</u>	<u>1984-85</u>
Canal Irrigation	8.3	10.4	12.8	15.3	15.9
Tanks	3.6	4.6	4.1	3.2	3.3
Tubewells	n/a	0.1	4.5	9.5	11.3
Other Wells	6.0	7.2	7.4	8.2	8.7
Other Sources	3.0	2.4	2.3	2.6	2.6
Tot. Net Irrig. Area	20.9	24.7	31.1	38.8	41.8
(Growth Over Previous Period; % p.a.)	(N.A.)	(1.7)	(2.3)	(2.3)	(1.9)

Source: Directorate of Economics and Statistics, Ministry of Agriculture.

<sup>1</sup> Refer Volume II, Chapter I for more detailed background and analysis.

<sup>2</sup> Throughout this report, the terms "net" and "gross," utilize Indian rather than international nomenclature. "Net irrigated area" refers to land area. "Gross irrigated area" refers to cropped area. Thus, where 1.5 irrigated crops are grown per annum on a 1,000 ha irrigated parcel of land, net irrigated area is 1,000 ha and gross irrigated area is 1,500 ha.

1.11 Irrigation has played a pivotal role in India's "Green Revolution." The spread of high-yielding wheat and rice varieties in the 1960s and associated use of fertilizer was made possible by increased volume and reliability of water supplies from irrigation. Irrigation also increased cropping intensity due to possibilities of growing crops outside the monsoon season.<sup>3</sup> The Green Revolution sustained agricultural growth at an average rate of 2.5%. While not spectacular, it was achieved in the face of limited productivity growth in rainfed agriculture. Agricultural growth was, however, heavily concentrated in the irrigated northwest and some irrigated areas in peninsular India where the water regime also permitted intensification.

1.12 Agroclimate. Irrigation in India must cater to widely diverse climates and socioeconomic conditions. Rainfall is seasonally concentrated, with most areas receiving 70-95% of mean annual rainfall from June to September. This concentration, coupled with dry periods during the monsoon, makes irrigation important for intensive agriculture in most regions. In the northwest (Punjab, Haryana and parts of adjacent states) the climate is dry with rainfall of less than 600 mm, but dry season river flows are supported by snow melt from the Himalayas. In eastern and central India (east Uttar Pradesh, Bihar, West Bengal, Orissa, Assam, and much of Madhya Pradesh), rainfall ranges between 900-1500 mm and even higher in some localities, with monsoon flooding a common problem. Most of peninsular India (Andhra Pradesh, Karnataka, Tamil Nadu, most of Maharashtra and southern Madhya Pradesh) has seasonally concentrated rainfall of 600-800 mm. Specific localities are affected by proximity to mountains and oceans; in Kerala, rainfall exceeds 1500 mm. High rainfall also occurs in the Himalayan foothills. Arid conditions prevail in western states (Rajasthan and Gujarat) and, to a lesser extent, in some rainshadow areas in peninsular India.

1.13 Monsoon intensity, duration and reliability influence the nature of irrigation required. In wetter regions, occasional but well-timed supplemental irrigation during dry spells of the "kharif" (monsoon) season is all that is required, while more regular irrigation is needed during "rabi" and summer seasons. In dry regions, irrigation is the main source of water determining crop growth, even in the kharif season. Other relevant physical factors are soils, topography and temperature. The degree to which groundwater is available is a particularly important factor, providing the option of well irrigation either by itself or in conjunction with surface irrigation.

1.14 Regional socioeconomics. Substantial differences in socioeconomic conditions and traditions also affect irrigation's performance. In eastern India, farms are small and fragmented and often under sharecropping or other tenancy systems. Yields are generally low and extreme poverty is widespread. Infrastructure, such as roads, electrification and availability of government agricultural support services, inputs and markets, is also poor. More favorable socioeconomic conditions prevail in northwestern states such as Punjab where population pressure is lower, farm holdings are larger and generally owner-occupied and unfragmented, and infrastructure and institutions are better developed.

### C. Impact of Irrigation

1.15 The development of irrigation has fundamentally influenced agricultural productivity, incomes, employment, and regional development. However, impact has varied considerably, depending on type of irrigation, agroclimate and, above all, on the technical quality and management of irrigation. Principal impacts (Vol. II, paras 1.6-1.39) are summarized below.

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<sup>3</sup> Irrigation development, while crucial, was only one of the factors affecting agricultural development. Other factors include availability of suitable improved varieties, fertilizer and other inputs, and support services such as extension, research and credit. Rural infrastructure such as roads, availability of markets, electrification, schooling and health services have also played an important role (Binswanger, 1989).

1.16 Cropping Intensity and Expansion of Cropped Area. While constraints on arable land prohibited expansion of net area under cultivation in the past two decades, gross cropped area expanded from 166 million ha in 1970 to 177 million ha in 1985, with an estimated 60% of this expansion due to irrigation. Still, average irrigation intensity remains low (1.29 irrigated crops per annum in 1984), due to the prevalence of run-of-the-river irrigation systems dependent on monsoon rains and primarily providing water for protecting the kharif crop. The main impact has been due to growth of groundwater irrigation, which markedly increased cropping intensity in regions such as the northwest.

1.17 Crop Yields. Average yields under irrigation are more than twice as high as yields under rainfed conditions (for cereals, 2t/ha, compared to 0.8t/ha rainfed), but low relative to yields under irrigation in other countries. This is mainly due to poor water management on the majority of the surface command area. Good irrigated yields are achieved (averaging 3t/ha/crop for cereals in the northwest and much higher for individual farmers and in some commands with ample water in parts of peninsular India), but yields are low in eastern and central India and in many commands in peninsular India. Farmers with access to water through private tubewells or dugwells generally have good to excellent yields.

1.18 Output Stabilization. Irrigation has helped reduce inter-annual fluctuations in agricultural output and India's susceptibility to droughts. Enhanced by improved transport linkages and Government's buffer stock system for food staples, the serious famines of the past are now less likely.<sup>4</sup>

1.19 Crop Diversification. Irrigation has only been selectively responsive to the needs of diversified agriculture. Combined with high-yielding varieties and price supports, it principally affected an increase in cultivation of wheat and rice, together accounting for two thirds of expansion in gross irrigated area since the 1960s. This overshadows the doubling of non-cereal area under irrigation, particularly of oilseeds, sugar, cotton, fruits, vegetables and dairying. Diversification to these crops, especially to fruits and vegetables, has been mainly facilitated by development of groundwater irrigation: private tubewells and dugwells, and in recent years, rapid growth of drip irrigation in peninsular India.

1.20 Farm Incomes and Employment. On average, farm incomes have increased 80-100% as a result of converting from rainfed to irrigated farming. Incremental labor days used per hectare average 60-80%. On larger farms, some of this represents incremental employment of non-family labor (usually from landless households or families with marginal farms). On smaller farms, incremental labor requirements tend to be handled by the family.<sup>5</sup>

1.21 Secondary Income and Employment Effects. Through its influence on agricultural incomes, irrigation development has a multiplier effect on non-farm incomes. Nonagricultural activities such as rural retailing, artisanal and industrial activities, processing and services grow as agricultural output and incomes rise. A 100-rupee increase in irrigated agricultural output stimulates 105 rupees of additional output in manufacturing and 114 rupees of additional tertiary

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<sup>4</sup> Commentators in the early 1980s (Mehra, 1981 and Hazell, 1982) noted a possible adverse impact of irrigation on output stability, but later analysis using more complete data (e.g., Dhawan, 1988) indicate an aggregate stabilizing impact, especially in regions of lower rainfall and where irrigation and drainage have been successful. At local levels, this may not be the case, in particular where farmers take up more intensive (more water-regime susceptible) agriculture and where irrigation unreliability and flood prospects, for instance in eastern India, are still present.

<sup>5</sup> The average impacts on employment and incomes noted above vary widely, depending on the effectiveness of irrigation (Vol. II, paras 1.22-1.26).

output, a total nonfarm output multiplier of 2.19 (Hazell and Haggblade, 1990)<sup>6</sup>. Expansion in agricultural output as a result of irrigation has also helped keep food prices down. Between 1970 and 1986, food grain prices in India fell by about 20% relative to the price index for all commodities. This has had significant impact on the real incomes of the urban poor and landless rural households for whom food is a large component in consumption.

1.22 Poverty Alleviation. Analysis of district-level data across India shows a strong relationship between agricultural productivity and the proportion of land area irrigated and associated usage of farm inputs (Bhalla and Tyagi, 1989). Similarly, the expected inverse relationship between the incidence of poverty and the extent of irrigation development has been demonstrated in district-level comparisons (Rao, 1988). For districts where less than 10% of gross cropped area was irrigated, 69% of the population had incomes below the poverty line, while in districts where irrigation covered more than 50% of crop area, poverty incidence was only 26%.

1.23 Regional Development. Regional impact has been dependent on availability of water resources and quality and extent of irrigation development. Past investment has been regionally concentrated, reflecting both water endowment and past policy emphasis on irrigation development in northern states. Since Independence, efforts have been made to broaden regional coverage of irrigation, especially in peninsular India, but given the distribution of water resources, such efforts will have limitations. Improving rainfed agriculture will, thus, be a continuing priority, as irrigation potential is inherently imbalanced by region.

1.24 Water resource endowment and investment have favored the northwest where irrigation has transformed agricultural productivity and general wealth. More than half of net cropped area is irrigated (82% in Punjab and 62% in Haryana). Between 1962 and 1982, the Punjab's net cropped area under irrigation increased from 53% to 82%, enabling rapid uptake of high-yielding varieties and fertilizer, and making the northwest the main beneficiary of India's Green Revolution. Other agricultural developments, including use of farm machinery, followed. While irrigation was not the only infrastructural influence, development would have been impossible without it. Under rainfed conditions (less than 600 mm), the land is only suitable for extensive pasture or drought-tolerant crops, such as sorghum and millet, with probable annual yields of less than one ton per hectare. Irrigated yields in Punjab average 3 tons per crop (rice and wheat) or 6 tons per annum. As a result, agricultural growth averaged 4.5% per annum during 1963-82, and Punjab's agricultural productivity is now more than twice that of India as a whole. In turn, agricultural growth has also stimulated the northwest's non-farm economy.

1.25 By contrast, agricultural growth in eastern and central India (48% of India's net cultivated area and one third of net irrigated) is less than 1% per annum. As share of net cropped area, irrigation currently covers 12% in Madhya Pradesh, 20% in Orissa, and about 35% in Bihar and West Bengal. Yields are low, despite substantial rainfall. The major factor is that poor-quality surface irrigation schemes have not proven responsive to seasonal crop needs. For the typical rice-wheat rotation, water is required before the monsoon, but most surface schemes can only deliver water after the monsoon is well underway, and water distribution is unreliable, not responsive to dry periods, and unevenly distributed between head- and tail-ends of commands.<sup>7</sup> A minority of farmers have bypassed these constraints with tubewell investments and obtain yields comparable to those in the northwest, but groundwater irrigation, while expanding rapidly in Uttar Pradesh and

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<sup>6</sup> The multiplier is higher in more developed states because of higher consumption linkages and input intensity.

<sup>7</sup> Timing is very critical. To obtain a good rice crop, water is needed before the monsoon to allow tillering (for good crop density) and fertilizer application before waterlogging. Earlier rice planting also enables earlier harvesting and then planting of wheat for growth during the cool months, critical for good wheat yields (India Agricultural Technology Review, 1989, India Agriculture Operations Division, World Bank).

parts of Bihar, is still limited in most of eastern and central India.<sup>8</sup>

1.26 In peninsular India, rainfed agriculture prevails and is likely to remain dominant. In the west (Gujarat, Rajasthan, Maharashtra), less than 20% of arable land is irrigated. In the south (Tamil Nadu, Andhra Pradesh, Karnataka and Kerala), net area irrigated is 48%, 32%, 20%, and 12%, respectively. Irrigation's impact is variable, ranging from excellent yields in some commands with ample water to the more prevalent situation of mediocre to poor yields due to weak water management. A common situation is unequal distribution of water, head-enders getting plenty to the detriment of tail-enders getting little or none.

#### D. Potential for Irrigation Development

1.27 Irrigation can have major impact on agricultural productivity, growth and on general development and poverty alleviation, as achieved in northwest India, in selected commands elsewhere, and with groundwater irrigation. Impact could be higher in all states and much higher in most states, particularly in eastern and central India and on many commands in peninsular India. Even successful irrigation in India has scope for improved productivity. Regional development concerns, especially for poverty areas, must also be considered.

#### Irrigation and Drainage

1.28 Irrigation's development potential cannot be stated precisely, due to acknowledged limitations in available data, lack of detailed river basin plans, separate estimation of surface and groundwater resources, uncertain assumptions regarding competing demands for water, and other factors.<sup>9</sup> The Central Water Commission's (CWC) 1985 assessment is the most recent official estimate (see Table 1.2). As recognized by CWC and discussed elsewhere in this review (Vol. II, Chapter II and Barber, Patel *et al.*, 1990), conservative interpretation of the official assessment is in order.

1.29 Official estimates put irrigation potential at 45.6 million hectares (113.5 million ha of ultimate potential minus 67.9 million ha of potential created). Of this, 28 million ha is estimated to be suitable for major and medium surface irrigation development and 17.6 million ha for groundwater irrigation. An additional source of expansion includes closing the gap between potential created and actual potential, estimated by government at over 7 million ha. While dimensions of the gap are open to question,<sup>10</sup> there is large scope for expansion through improving water distribution on existing schemes, construction of micronetworks and completion of ongoing projects. A second source of expansion, not included in Table 1.2, is the transfer of water from river basins with surplus water to water-short basins. Aggregate potential from such schemes has been broadly assessed by CWC to be up to 25 million ha. Such transfers would be expensive and require water-sharing cooperation between states. If technically and economically viable, transfer schemes to water-short southeastern and western basins may be necessary over the

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<sup>8</sup> The constraints in eastern and central India are complex, involving, in addition to poorly performing irrigation and drainage, poor infrastructure, socioeconomic factors such as land tenure and caste structure, and weak institutions. Inadequate control of water is, however, a basic factor, also affecting the possibilities for using high-yielding varieties and fertilizer (Pray, 1991). Other commentaries are in: *Agricultural Productivity in Eastern India*, RBI, 1984; and *Report of Study Group on Agricultural Strategies for Eastern Region of India*, Planning Commission, 1985.

<sup>9</sup> For example, dependency on assumptions regarding capturable surface run-off, the rate of groundwater recharge, irrigation efficiency, and the intensity of water usage on irrigated lands.

<sup>10</sup> Potential created may be overestimated because irrigation efficiency estimated at design is often too high, further compounded in practice by farmers using cropping patterns requiring more water than originally assumed.

long term.

Table 1.2 Government Estimates of Status of Indian Irrigation Development in 1985

	Major & Medium Schemes	Minor Schemes	Total
	----- million ha -----		
Ultimate Potential (1981 estimate)	58.5	55.0	113.5
Potential Created (at 1985)	30.5	37.4	67.9
Potential Utilized (at 1985)	25.3	35.2	60.5
Balance (Ultimate minus Created)	28.0	17.6	45.6

Note: Additional potential from river-basin transfers (para 1.29) are not included in ultimate potential.  
Source: CWC

1.30 There is a clear need for stronger hydrological data and revised assessment of development prospects based on water's natural hydrological unit, the river basin. Until then, assessment of potential can only be indicative. Realizing this potential will be more technically difficult and costly than in the past and most opportunities will depend on creating additional storage capacity. Potential is also regionally concentrated and must cater at local levels to competing demands for water use. Nevertheless, within these uncertainties and constraints, prospects for expansion are present, as discussed below:<sup>11</sup>

1.31 Groundwater Irrigation. Prospects for further groundwater irrigation, while less than official estimates of 17.6 million ha, are still significant. In many of India's river basins, there is substantial scope for continued rapid expansion of groundwater irrigation over the next 10 and perhaps 20 years. The greatest potential is in eastern India. Moderate but localized potential also exists in western and southern states. However, in parts of the northwest and west, exploitation has reached its limit. In dry areas with limited natural recharge, groundwater irrigation prospects are largely of a conjunctive nature, dependent on recharge due to availability or expansion of surface irrigation. Its future is thus closely interlinked with development of surface irrigation.

1.32 Surface Irrigation. Possibilities for new run-of-the-river schemes are virtually exhausted and investment in new surface irrigation will be almost entirely dependent on creation of additional water storage capacity. Capturing surface runoff is particularly important in India, with most rivers carrying about 80% of their flow during the monsoon months. Estimates of surface irrigation potential (28 million ha) assume high utilization of natural runoff, but this will be difficult to achieve in practice as good dam sites for creating additional storage are limited in most basins. Even so, at the current expansion rate (about 220,000 ha net per annum) or at a faster development rate, sufficient opportunities are available in India for expansion of surface irrigation through several decades.

1.33 Investments in storage reservoirs can be expected to have higher development costs and marginal rates of return (para 1.49). Further, the issues of finding satisfactory solutions to environmental problems and resettlement and rehabilitation of populations displaced by reservoir developments will be more prominent. Additionally, many future options would require interstate agreements on water-sharing. Planning and administration of projects that cross state boundaries

<sup>11</sup> For more detailed discussion and assessment, refer to the approximate river basin and state estimates in Vol. II, Chapter II and its supporting annex and to "Assessment of Indian Water Resources and Irrigation Development Potential," W. Barber, C.C. Patel *et al.* (Irrigation Sector Review Background Paper, 1990).

are already a problem. Despite these issues, investment for the future in water storage is essential now in certain areas, and will be the basis for longer-term water development throughout India.

**1.34 Drainage.** Investment in drainage has been widely neglected, and where such investment has been made, poor maintenance has caused many drainage systems to become silted up. A large part of both rainfed and irrigated eastern and central India, most of the eastern deltas, and localized bottomlands of irrigated commands elsewhere in India are subject to waterlogging and flooding during the monsoon. In addition to crop failure, the more widespread problem is that excessive water imposes limitations on varietal choice, fertilizer application, and cropping patterns, all affecting yield. In the eastern Gangetic plain, investment in surface drainage is likely to have larger productive impact, and at lower cost, than investment in surface irrigation.<sup>12</sup>

**1.35** Additionally, parts of northwest India and Uttar Pradesh (250,000-500,000 ha) are affected by a build-up of saline groundwater; in extreme conditions land has gone out of production. In these areas, more expensive groundwater drainage is required if agriculture is to remain sustainable.

### Regional Development

**1.36 Northwest.** Only limited extension of irrigated area is possible in the northwestern states of Punjab and Haryana and parts of adjacent states where potential is fully utilized, especially in Punjab. The Punjab Irrigation and Drainage project (Cr. 2076/Ln. 3144) will complete marginal extensions for surface schemes, improve efficiency of surface water delivery, and improve groundwater drainage. Some additional surface water irrigation is feasible for Haryana if storage is constructed on the Yamuna in the Uttar Pradesh hills. Modest additional groundwater development is possible in localized areas of Haryana, while in almost all of Punjab, groundwater is fully developed. However, major additional investment is required in surface and groundwater drainage in southwest Punjab, Haryana and in adjoining areas in other states to combat increasing waterlogging and soil salinization.

**1.37 East and Central.** The largest unexploited irrigation potential is in eastern and central India. Uttar Pradesh, Bihar, West Bengal, Orissa and Madhya Pradesh together are estimated to have 56% (up to 25 million ha) of the country's untapped potential.<sup>13</sup> The most attractive opportunity is for groundwater development (40% of east and central India's irrigation potential). However, while good groundwater prospects exist in all these states, development needs to be confined to areas where exploitation would not adversely affect dry-season Ganga river flows, i.e., where the water table is high and subject to monsoon waterlogging. Major opportunities are available for improving water management on surface irrigation schemes, investing in drainage and flood protection to reduce risks and improve kharif yields in areas with excessive wet season water, and tackling the problem of saline and sodic soils in Uttar Pradesh. For many years to come, expansion of surface irrigation can focus exclusively on completion of the substantial backlog of ongoing projects, especially in Madhya Pradesh and Orissa.

**1.38 South.** In 1985, only 6.5 million ha of irrigation development potential was estimated (14% of India's remaining potential) for southern India, and this is likely to be an overestimate. Over half is in Andhra Pradesh. Tamil Nadu has fully developed its water resources, while the demands of conurbations such as Madras are increasing. However, some scope exists for

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<sup>12</sup> "Land Reclamation and Drainage," L. K. Smedema, (Irrigation Sector Review Background Paper, 1990).

<sup>13</sup> As at 1985, based on GOI's assessment.

localized groundwater irrigation and better economies in water usage on existing surface commands.<sup>14</sup> In Andhra Pradesh and Karnataka, completion of ongoing surface schemes and improving water management of existing scheme are priorities. Some potential exists for creating additional storage on the Godavari in Andhra Pradesh, and there is moderate scope in both Andhra Pradesh and Karnataka for additional groundwater development. Investment in drainage may be attractive in irrigated areas of the southern states, especially on the waterlogged and flood-prone delta schemes. Longer-term expansion of irrigation in southern India will depend on the technical and economic feasibility of water transfers from surplus basins further north and across the Western Ghats from Kerala.

1.39 West. The states of Rajasthan, Gujarat and Maharashtra have moderate remaining potential for irrigation development, some 6.8 million ha, based on the 1985 estimate. Both existing and potential irrigation is highly localized, leaving large areas of these states still dependent on rainfed farming. Groundwater potential exists in all three states, especially Maharashtra, but may be only 25% of the region's total remaining potential and in many localities is dependent on conjunctive use with surface irrigation. The bulk of surface irrigation potential is represented by incomplete, ongoing projects and the Narmada development program, particularly significant to the region's development prospects. The Narmada's Sardar Sarovar projects (Cr. 1552/Ln. 2497 and Cr. 1553) will service rapidly growing municipal and industrial needs, furnish hydroelectric power to the regional grid and provide irrigation for a 1.8 million ha command area in arid Gujarat.

#### E. Economic Viability of Irrigation and Drainage Investment

##### Past Performance and Viability

1.40 The economic viability of irrigation investments in India has been critically affected by implementation, which has been weak in most cases, particularly so on government-financed projects. Economic rates of return are not calculated by government, so this assessment must be based on comparison of performance relative to World Bank-assisted projects; despite many deficiencies, Bank projects have tended to fare better. Notwithstanding efforts to undertake more thorough project preparation, basic weaknesses in data, project design, detailed engineering and planning have resulted in inappropriate project features. Adjustments to rectify deficiencies during implementation have not been easy to make and have contributed to implementation delays. Project appraisal has often been conducted before all design and institutional features have been finalized or resolution of land allocation, resettlement or environmental issues, also contributing to delays and poor implementation. Additionally, during implementation, inadequate government supervision of contractors has caused delays, substandard works requiring reconstruction, and cost overruns. Poor coordination across government departments has also impeded execution and reduced quality. And, most importantly, once constructed, most irrigation schemes have been poorly operated and maintained, other services (extension and research) have been inadequate, and yield potential seldom realized.

1.41 As a result, re-estimated economic rates of return (ERRs) for World Bank-assisted projects at completion have been poor. Of nine projects subject to project completion reports (PCRs) in 1989, all with satisfactory ERRs estimated at appraisal, only two had re-estimated ERRs above the estimated opportunity cost of capital in India of 12%. Four had ERRs of 5% or less. Although a decline in world rice prices in the mid-1980s had some impact, poor implementation was the primary influence. In seven projects, capital investment costs were substantially higher than anticipated, with cost increases of 49-147%. Seven projects also experienced implementation delays, substantial in several cases. Other important factors, most still not fully captured in the economic analysis of PCRs, were reduction in command areas expected to be irrigated, shortfalls

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<sup>14</sup> This is, however, limited as many schemes (including the tank irrigation systems) are in cascade; losses on one scheme are utilized on another downstream scheme.

in yields, and downward adjustments in cropping patterns assumed at appraisal. Similar results were noted by Daines and Pawar (1987) in economic analysis of government-funded projects. More often, performance problems have been greater on government-funded projects, due to hastier project preparation, less attention by state and central governments during implementation, and funding constraints that slow implementation.

1.42 Despite substantially better ERRs in PCRs on earlier World Bank projects, there is little to indicate that recent results are exceptions. Based on field observations and analysis of the methodology used for calculating ERRs in earlier PCRs, the most reasonable conclusion is that project performance and economic viability have been poor all along for most projects.<sup>15</sup> Of 13 projects completed between 1970 and 1984, two had ERRs of less than 12% and half had ERRs greater than 20%. However, half overran cost estimates at appraisal by 50% or more. Moreover, PCRs did not take into account that yields and actual irrigated area were likely to be smaller than assumed at appraisal, even when field observations might have indicated that this was likely to be the case. Rising rice prices also improved PCR rate of return estimates during that period.

### Returns by Type of Irrigation Investment

1.43 What kind of investments in irrigation and drainage have maximum viability as future investments? The observations below, based on ex-post and ex-ante ERR indicators, provide some guidance.<sup>16</sup>

1.44 Groundwater Irrigation. Groundwater irrigation with small private shallow tubewells and to a lesser extent with dugwells, each serving about 3-4 ha, have been estimated to have ERRs in excess of 30% (Daines and Pawar, 1987). Even with adjustment of electric power costs, which may be underassessed here, economic returns are high. Private tubewells enable farmers to control water so that irrigation can be tailored to crop needs. Financial returns to farmers from groundwater development are even greater than the economic returns, as investment costs are partly subsidized and electrically operated pumps highly subsidized. Although diesel fuel is unsubsidized, diesel-operated tubewells also have high financial returns, as benefits from high yields substantially outweigh investment and operating costs.<sup>17</sup>

1.45 Public tubewells (deep tubewells constructed, maintained and operated by government and designed to serve farmers in an 80-100 ha block) are much less viable. Appraisal of World Bank-financed projects in Uttar Pradesh, Bihar and West Bengal put estimated ERRs at 30-40%, but assumptions about command area served, yields, and cropping intensity have proved to be too optimistic. Field observations indicate modest impact on average productivity and difficulty in sustaining these investments, which can be expected to be reflected in ex-post ERRs. The ongoing Indo-Dutch tubewells project in eastern Uttar Pradesh, modelled after the World Bank project (Cr. 1332), has a re-estimated (1990) ERR of 9%, using more realistic assumptions based on current experience. Recent World Bank analysis concludes that fostering private groundwater irrigation

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<sup>15</sup> Re-evaluation of several earlier PCRs is currently being undertaken by the Operations Evaluation Department, World Bank.

<sup>16</sup> Wherever possible, ex-post ERRs have been used. Where ex-ante ERRs are compared against each other, the assumption is that they provide some indicator of comparative economic viability in a situation where performance is reasonable. Refer Vol II, Chapter III for more detailed analysis.

<sup>17</sup> Diesel prices, although regulated, are adjusted periodically to approximate international prices at the official exchange rate. A further upward adjustment to reflect exchange rate distortions would be desirable.

with shallow tubewells is the more attractive development option.<sup>18</sup>

**1.46 Existing Surface Irrigation.** Available data support the economic viability of expenditures to improve performance of existing surface irrigation systems. Substantial sunk costs have already been incurred, and the incremental cost of institutional improvements and infrastructure are relatively low, compared to substantial potential gains in productivity and efficiency. Improvement options include: better operations management; more intensive modernization of irrigation schemes; development of micronetworks (watercourses, field channels and field drains); and upgraded agricultural extension and adaptive research (on crop varieties, cropping systems and irrigation technology).

**1.47** For example, the National Water Management Project (Cr. 1770, para 4.23) aims at improving efficiency of water distribution, mainly by upgrading planning and management and some water control structures. At appraisal, ERR estimates were over 30%, and encouraging initial results are being encountered in some states. Projects that involve more intensive investment to upgrade and modernize the irrigation system, ranging from water control systems to canal lining, also have generally higher ERRs at appraisal than those for new surface irrigation. Actual returns have varied, depending on implementation: the Punjab Irrigation Project (Cr. 889) yielded an ERR at completion of 36%, while the second Chambal project in Madhya Pradesh (Cr. 1288) achieved 10%. The viability of canal lining depends on physical features and the quality of lining. Where seepage beneficially recharges groundwater without waterlogging problems and such water can be retrieved by tubewells, lining is often not justified. In all cases, quality must be good (and often has not been) if lining is to be beneficial. Less analysis is available on the impact of micronetwork development, but high economic viability can be expected. Irrigation cannot fulfill its function until the tertiary system is developed and well functioning, still a major weakness on most commands. Similarly, provision of water must be accompanied by good agricultural extension, another common weakness, and applied irrigation technology and agricultural research are fundamental to improving irrigation and agricultural yields.

**1.48 Drainage.** Investment in drainage infrastructure can be expected to have good economic viability. In the eastern Gangetic plain (both rainfed and irrigated areas) and in many deltas, as well as localized bottomlands in surface commands elsewhere, surface drainage can substantially reduce waterlogging problems and the duration of temporary flooding. Good impact can be anticipated on crop intensification and diversification opportunities available to farmers. Investment costs for surface drainage systems would typically average Rs 1500-3000/ha (less than US\$ 200). This is estimated to make such investment economically viable on between 5-10 million ha (Smedema, 1990). Additionally, more expensive groundwater drainage and land reclamation measures are needed in parts of northern India (para 1.35).

**1.49 New Investment in Surface Irrigation.** New surface irrigation projects have lower economic returns than investments to improve the productivity of existing schemes. Typical estimates of ERRs at appraisal have been between 10% and 20%, but as discussed above, these have seldom been attained. While better project preparation and implementation can greatly improve the past low returns to new irrigation investment, all indicators point to modest economic viability. Experience suggests that moderately well performing, new surface irrigation projects would yield ERRs of between 5% and 10%, while excellent performers or projects with particularly advantageous features could yield 10-15%.

**1.50** Higher rates of return can generally be obtained from investments to complete the substantial backlog of ongoing irrigation projects. According to government estimates, some 1200 major, medium and minor irrigation projects are in this category, including 142 major and 216

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<sup>18</sup> See "Uttar Pradesh Groundwater Development, Issues and Options," India Agriculture Operations Division, World Bank, February 1991.

medium projects.<sup>19</sup> Intrinsically higher viability is due to the presence of sunk costs and, hence, the higher returns of incremental investment to complete these works. However, ERRs above the opportunity cost of capital are by no means automatic. A number of past projects with poor economic returns as re-estimated at completion have been of this nature. Implementation performance remains critical, and within the substantial backlog of projects to choose from, careful selection is needed of those with the highest viability and justification.

## F. Needs for Future Investment

### Strategy Shift

1.51 Despite limited performance, expansion of irrigated agriculture has largely driven agricultural growth in India. Irrigated agriculture will remain the main source of growth for the foreseeable future, but the investment emphasis must shift from physical expansion of new capacity to productivity increases based on better performance from existing surface irrigation and selective investment in groundwater, completion of ongoing viable projects, and drainage.

1.52 An "extensive" or "protective" strategy has dominated Indian irrigation, originating from the country's experience with droughts and famines in the 19th and early 20th centuries, and more recently influenced by equity concerns and political objectives of spreading benefits as widely as possible. The goals have been to spread water over as large an area as possible and to ensure at least a basic cereal crop in the monsoon season. In practice, inequities in water distribution and the taking of water by head-end farmers has resulted in de facto intensive irrigation on sub-areas of commands, while other areas receive little or no water. Also, there is an increasingly poor fit between the water requirements (timing, reliability and quantity) of more intensive and diversified agriculture and the basic and unreliable supplies of many surface irrigation systems. The outcome is strained management and reduced productivity. The strategy has worked well in the northwest due to good practical application, favorable local conditions, and the additional flexibility provided by conjunctive groundwater irrigation. Elsewhere it has often encouraged use of overly optimistic design assumptions on water availability and irrigation efficiency. Design needs to be more realistic and the costs of alternatives assessed against benefits.

1.53 The extensive strategy has also influenced the emphasis on investment for new irrigation rather than consolidation of benefits from existing investment. Since the productivity of irrigation is a more important determinant of agricultural growth than its rate of expansion (Vol II, Chapter IV), actions should concentrate on productivity of existing infrastructure. In turn, improved productivity would provide an economic justification for investment in expansion of irrigated area.

### Investment Choices

1.54 Emphasis on Performance. There is substantial room for improved performance. Serious implementation issues need to be tackled, as discussed in subsequent chapters. An essential requirement is to ensure that existing irrigation remains in good repair, preserving its capability to perform. Beyond this, the most pressing need is widespread improvement in water management, complemented by improved agricultural extension on optimal water usage and agricultural practices. On most commands, the development of micronetworks is also an important call on investment, in essence, to complete utilization and magnify returns at the local level. These thrusts can be supplemented on selected commands by higher-tech investment to further intensify production.

1.55 Selective Expansion. Expansion of irrigated area, while having smaller impact, is still necessary to ensure agricultural growth but expansion needs to be refocussed on economic

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<sup>19</sup> Defined respectively as: major, over 10,000 ha; medium, 2000-10,000 ha; and minor, less than 2000 ha.

viability, rapid implementation, and lowest public expenditure. Expansion of private groundwater irrigation is particularly attractive and should be fostered through supporting public sector investments and policies. Through the medium term, expansion of surface irrigation should be almost exclusively confined to completion of viable ongoing projects. Huge scope exists and in many states completion will take over a decade. Finally, surface drainage offers opportunity for greatly improving productivity of both irrigated and rainfed agriculture in waterlogged areas. More costly drainage investments are required in some areas to preserve or rehabilitate lands affected by rising water tables and salinization.

**1.56 New Surface Investment.** With rare exception, there is no justification in the medium term for new surface irrigation investments. Inherent economic viability, even under good implementation, is typically modest to low. The only compelling justification for new investment is regional development concerns: where water needs are paramount and other water development options are not available, such as the Narmada program for combined household, industrial, power and irrigation development in water-deficit western states, or for river basin transfers to water-short southern states where technically and economically viable.

**1.57** New surface irrigation investments will become more relevant over the longer term, from early next century in some states. Expansion due to project completion will have been accomplished and prospects for groundwater development gradually exhausted (later in parts of eastern and central India) and increasingly dependent on conjunctive use, replenished by percolation from surface irrigation. Options with lower viability will then be a consideration.

**1.58 Broader Economic Analysis.** A question of increasing relevance will be: What is an acceptable economic rate of return for such investments? Broader considerations than the benefits included in standard ERR analysis are probably needed. Infrastructural investments have development impact beyond first-round benefits captured by the rate-of-return calculation. They enable other higher-viability investments and multiplier effects on employment and general development, as illustrated by the impact of investment in irrigation in northwest India. In the case of well designed and implemented projects, secondary and tertiary effects can reasonably be expected and investment justified, particularly where ERRs approach the opportunity cost of capital. Clearly though, in the medium term, they have lower priority, given the more viable options for improving productivity or expanding area, with faster impact and lower public expenditure cost. Except where strong regional development considerations apply, new investments can be considered later.

## G. Framework for Strategic Choice

**1.59** Coming to grips with the inefficiencies in performance of the Indian irrigation sector necessitates answers to four straightforward questions: What is possible and how should this be planned? What are the priorities for public expenditure? How can technical implementation be improved? Who should manage and execute in order to get the best results? Answers to these deceptively simple questions will comprise the sector's strategic framework for the 1990s. In concert, the answers will guide policymakers and implementors on actions to improve productivity, ensure sustainability, refocus investment, and strengthen sectoral management. Four major actions are required:

**1.60 Forge a Coherent Water Resources Policy.** Complete data on the availability and distribution of water are needed as a first-step in planning investment for effective usage of a limited resource. The natural hydrological unit, the river basin, is the essential planning unit, yet its boundaries rarely coincide with political boundaries. Ground rules and mechanisms for sharing water and coordinating usage across boundaries and among competing users -- agriculture, industry, municipalities, etc. -- need to be hammered out. Holistic planning and management are needed as demands for water-sharing increase. With this approach, firmer grounds are established

for investment choice that is responsive to users, sectors, regions and technology. Environmental and resettlement policy also needs improvement.

1.61 Prioritize Expenditure and Tighten Financial Management. Public funds for investment in irrigation are limited by budgetary constraints and further are being squeezed by recurrent expenditure. More transparent budgeting and accounting procedures would point to shrinkage in investment per se. The widening discrepancy between expenditure and revenue is rooted in extremes on both sides of the ledger -- rapidly rising staff costs and declining revenue from user charges. Both must be brought under control. Investment must be prioritized to achieve maximum impact. This context envelopes decisions on whether to upgrade existing infrastructure or build new capacity and on what balance to strike among groundwater, surface irrigation, and drainage investment, to cite a few.

1.62 Improve Technical Performance. Improving sector performance hinges on more than narrow technical choices. Broadly, it encompasses strategy, agroclimate, project design, construction, operation, maintenance, management, and responsiveness to community needs. The overall scope for improvement on all these fronts and in most states is considerable. In particular, technical implementation requires improvement in water management, maintenance, design and construction.

1.63 Reorder Government/Private Roles and Build Capacity. Investment in irrigation does not necessitate exclusive public management and investment. Government cannot afford to undertake and manage all irrigation investment. Nor should it. Critical analysis is needed on what government should be doing and where privatization would be beneficial. Autonomous commands, farmer constructed and managed micronetworks, and consultant, NGO and university involvement in data collection, analysis, project planning and design are only a few of the possibilities. Where government does plan and execute, its capacity to do so must be enhanced and its units restructured to accommodate more specialist expertise across more disciplines. The construction engineering approach should give way to a broader-spectrum management culture.

1.64 The chapters that follow will address these four strategic actions in turn. (See Annex I for matrix table on highlights of recommended action.)

## CHAPTER II. WATER RESOURCE POLICY AND PLANNING

2.1 Effective planning and coordination of water resource development are essential if India's scarce water resources are to be efficiently developed. GOI's National Water Policy (1987) provides a framework for coordinated water development across states and alternative uses of water, and it emphasizes the need for river basin planning. A basic constraint, however, is the constitutional definition of water as a "state subject" in India. The National Water Policy has had little follow-up, due to lack of institutional mechanisms to plan, coordinate and implement water development across boundaries and among users. The essential problem is that water use cannot be effectively planned on a state-by-state basis. Water resources are defined by the natural hydrological unit, the river basin, and only one of India's 18 major river basins is contained in a single state. Further, as water scarcity increases and multiple demands on usage grow, conflicts among users will increase. Already, such conflicts are common. More important, uncoordinated past and present decisions on water use are diminishing possibilities for optimal water use and will limit future development prospects.

### A. Situation and Trends

2.2 Development Strategy. Maximizing returns to water implies widespread infrastructure to spread water. India's historic irrigation development strategy of spreading water as widely as possible ("protective" or "extensive" irrigation) has resulted, in practice, in substantial shortfalls, mainly due to design and implementation problems, except in the northwest. Stretching water supplies over larger areas to address protective or equity concerns cannot be applied indefinitely without eventual conflict with efficiency and production objectives. Beyond a certain point, economic viability diminishes as net incremental benefits fail to cover the additional investment costs in distribution networks. Eventually, gross output will also fall as water quantities become so overstretched that productive impact is impaired or farmers, frustrated by limited water, take more than their share or break the system. Overly optimistic design assumptions concerning availability of water and feasible irrigation efficiency have also meant that many systems do not have enough water to operate as assumed at the planning stage.

2.3 Limited Availability. India's water resources are limited in aggregate and distributed unequally across regions. Both groundwater and surface irrigation development are constrained by such physical limits and in some regions these limits have already been reached. In the northwest, water development has nearly reached its physical limit. In Tamil Nadu, state water resources have been fully exploited and further development will depend on greater access to water from the Cauvery river flowing through upstream Karnataka, or to any eventual prospect for transferring water across the western Ghats from Kerala. In western India further development depends on major storage-based schemes (e.g., Narmada). Development is also constrained by riparian rights of other countries. The successful Indus Basin Treaty between India and Pakistan has clarified the respective usage rights of the two countries and permitted non-conflicting investment, but its adherence is part of the limit on northwest water development. For the Ganges basin, dry season flow requirements to Farakka barrage serving downstream Bangladesh will need careful planning of future water development on India's part. The interlinked nature of groundwater and surface water must also be recognized. Exploitation of one affects the potential development of the other, yet each is measured independently and water development for these resources has seldom been planned conjunctively.

2.4 Further, as a scarce resource relative to land, efficiency in water use must be encouraged, through rationing or pricing. Apart from the warabandi system (rationing) and use of diesel fuel for pumps (priced according to each liter of water used), measures to encourage economy of water use are seldom applied. Crop-based water charges on surface schemes (high water charges for more water-intensive crops), to some extent, capture differences in use by crop, but not the actual water use. Further, they are set too low to have any impact on cropping decisions. This lack of

effective rationing or water pricing has its consequences on water-use efficiency. Sugar growers in Maharashtra occupy 10% of cropped area and use 50% of irrigation water (Rath and Mitra, 1987). Abundant water in some commands of southern India, in designated "wet" areas of localization schemes, and in head-reaches of most commands throughout India implies lack of water for other farmers.

**2.5 Competing Uses of Water.** Community water for urban and rural populations, livestock, and water for industry, thermal power, hydropower, and river flushing and navigation compete with irrigation. Irrigation is the largest user of water in India, accounting for 93% of present gross water use. However, community use is expected to double and industrial and power use increase seven-fold by 2025. While this would not limit the availability of water for irrigation overall (irrigation would still use an estimated 90% of overall net demand), the regional distribution of water demand relative to supply is a problem. High community and industrial demand already present water supply problems around urban concentrations in Delhi, Madras, Bombay and other cities, particularly in peninsular India. The concentration of heavy industry and thermal power generation around Jamshedpur in Bihar will take the bulk of Bihar's share of future water development under the Subernarekha development program. Areas in some southern states (Tamil Nadu) and western states (Gujarat, Rajasthan) are experiencing shortages in community and industrial supplies. Water supplies for community use must be secure and take precedence over irrigation. Irrigation development will thus have to be planned and implemented in the context of multi-purpose usage and the usually higher claim on water for municipal, industrial and some other uses. Planning is woefully inadequate and under-emphasized. Initiatives to improve matters have been beset by the political difficulties of reaching agreement between states.

**2.6 Institutional Constraints and Mechanisms.** As situations of water scarcity and competing needs mount, the inadequacy of existing water policy and its implementation become increasingly apparent. The constitutional nature of water as a "state subject" means that states have full authority over water use and legislation within their borders, encouraging disparate decisions without reference to water basin usage as a whole. Two acts have provided some mechanisms to tackle inter-state water issues. The River Boards Act of 1956 gives GOI the authority to set up a river board for any inter-state river, but the boards' functions are solely advisory. More significant powers are available under the Inter-State Water Disputes Act of 1956, which authorizes GOI to refer any water dispute to a legal tribunal for adjudication, with findings of the tribunal being final. For groundwater development, state governments have exclusive constitutional authority. While some success in harmonizing inter-state riparian development has been achieved through cooperation and specific tribunals (for instance, in the sharing of Narmada, Krishna and Subernarekha waters according to tribunal awards), the more common situation is lack of agreement. The findings of the Ravi-Beas tribunal in the Indus basin have yet to be finalized, and a highly contentious inter-state dispute among Tamil Nadu, Karnataka and Kerala regarding the waters of the Cauvery has remained unresolved since 1974. Sharing of Yamuna waters between Haryana and Uttar Pradesh is still a matter of dispute, despite an inter-state agreement.

**2.7 Water-sharing and River Basin Planning.** In industrial countries where water-sharing issues have persisted for some time, river basin planning has usually become standard practice with holistic consideration of its multiple uses.<sup>20</sup> Progress towards holistic water planning and

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<sup>20</sup> In England and Wales, river basin water resource authorities are separate from local administrations and have overriding powers as concerns water administration following a principle established in the 16th century. Similar procedures were initiated in France in the 19th century, and completed in the 1960s through the creation of river basin agencies for its main rivers. Canada and Germany also follow a river basin approach. In the United States, federal authority over water is restricted to a consultative process including examination of environmental issues. But major interstate rivers have come under river basin planning commissions, and agreements between states are bound by inter-state compacts recognized under law. The legislative process and commercial water transactions are principal means for resolving water disputes, a procedure less suited for countries where the

implementation is more variable in Asia. In China, river basin planning is fairly well established. In the Philippines, the National Water Resources Board has the mandate to conduct river basin surveys and coordinate water allocation among users. The country is divided into water resource regions partly corresponding to river basins but also influenced by administrative boundaries. In Indonesia, where water is constitutionally recognized as a central government as well as local responsibility, river basin planning has begun, though it is still rudimentary. Three river basin implementation authorities have been established, though their roles are not yet clearly defined. In India, the Damodar Valley represented a serious attempt at planning and implementing whole basin development. Elsewhere, ad hoc decisions have generally been necessary, usually project by project, with high opportunity costs in terms of conflicting development or lost opportunities for better resource-sharing.<sup>21</sup>

2.8 In India, neither state nor central government administrations can effectively deal with the whole river basin as the planning unit. The states have specific interests which are generally narrower than those required for whole basin planning. The center has limited powers and would in any case be too far removed for the detailed analysis and decision-making required. Institutional arrangements and lack of coordinating mechanisms complicate policy and implementation at both levels. Separate GOI agencies exist for surface water (the Central Water Commission, CWC) and for groundwater (the Central Groundwater Board, CGWB). The results are separate accounting of each and over-estimation of combined water resources.<sup>22</sup> Efforts to coordinate activities by the Ministry of Water Resources (MOWR) and other central ministries involved with water (mainly, Energy for hydro and thermal power, Environment and Forests for catchment conservation and pollution, Urban Development for urban water supply and sanitation, and the Planning Commission) have suffered from limited powers at the central level and the difficulties inherent in cooperating across sectors. Cooperation among departments responsible for different aspects of water use at the state level has also proven difficult.

## B. Tackling Resource Planning and Policy Issues

2.9 River Basin Planning. Establishment of procedures and institutional capabilities to undertake holistic planning and coordination of water development by river basin and including all uses of water is the most essential need. This requires substantial change in water policy implementation, improved data collection and analysis, and the creation of institutions at river basin and sub-basin levels.

2.10 Central Powers. A controversial need is to decide on the degree of power vested at the center relative to the states. At present, minimal central power is an important reason why agreement between states and progress towards river basin planning has lagged. Rapid progress in China, Indonesia, and the Philippines has been enabled by the power of central government to lead the decision-making process, which at least one regional or sectoral entity would otherwise obstruct (the one which might stand to lose resource usage). This is less easy in the Indian democratic structure where state rights are greater. The use of Plan funding conditionalities (para 2.13a) will help enforce compliance with national and inter-state interests. Cases of development with state funds to the detriment of a downstream user have, however, occurred (e.g., Karnataka with Cauvery waters). More aggressive use of tribunals to effect decisions and transfer of

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legislative apparatus and water pricing are less established. Unresolved disputes are common in the United States, suggesting that greater central capability to settle disputes (as in the United Kingdom and France) may be more appropriate, especially in developing countries.

21 For further discussion of water planning and resource issues, see Asia Water Resources Study (Asia Region, Agricultural Technical Division, World Bank, draft, 1991).

22 As commented upon by CWC (1988), but not yet adjusted for in official estimates of water availability.

authority on water decisions to river basin commissions would also help promote change, but would depend on the assumption that the states are prepared to comply. A desirable additional step would be to change the constitution so that water resource planning is a "concurrent" subject (joint responsibility of both central and state governments), a situation found for other sectors (power, transport), which arguably require no more inter-state and state-national cooperation than water. While this would require national debate and two-thirds majority agreement by states, it would be an important fundamental change. The center would then have greater ability to effect change, establish river basin commissions and tribunal awards and resolve conflicts. Implementation at river basin, sub-basin and project levels nevertheless needs to remain a local responsibility, but the institutional changes and inter-state agreements necessary to achieve this would be helped by greater power at the center to promote decision-making and coordination.

2.11 Coordinating Mechanisms. The present separation of surface and groundwater responsibilities between CWC and CGWB encourages disparate consideration of surface and groundwater resources. The two agencies should be merged or better mechanisms created through MOWR for a joint approach. Also, there is a need for GOI to provide greater cross-sectoral coordination for water planning, possibly achievable through an overview senior committee comprising the Planning Commission and ministries involved. This, rather than CWC, a technical agency, should have principal authority in water allocation decisions and should include state representation.

2.12 Water-pricing. As an allocative mechanism, water pricing should increasingly be used, including in agreements on water-sharing. Agreement between states and different users in India would be facilitated if water was priced. It is employed, inadequately, by states for distribution to nonagricultural users, but not between states. Yet doing so is a likely precondition for successful future river basin transfer schemes. For instance, any future plan for transfer of water from the western ghats in Kerala to water-short Tamil Nadu could involve fees to Kerala for the opportunity cost (e.g., foregone future hydroelectric power) and investments involved. Similarly, agreement between India and Nepal for investment in storage in Nepal's part of the Gangetic basin would require clear agreement on water-sharing, investment funding and fees charged for water and hydroelectric power.

### C. Actions to Improve Water Policy and Planning

2.13 The following actions are recommended:

- (a) Reaffirm and enforce the National Water Policy. Each state should reaffirm the National Water Policy and prepare a "State Water Policy" fitting within the framework of that policy and river basin plans. The National Water Policy paper may require some updating as part of this process. Central Plan funding for state irrigation investments should be made conditional on the existence of a state water policy and its fit within the river basin plans;
- (b) Establish river basin planning commissions for major river basins. These should be charged with preparing river basin plans for multiple use of water and for coordinating and authorizing specific developments;
- (c) Establish autonomous implementation authorities for specific projects requiring coordinated water use between states or users. These autonomous agencies should operate within the general guidance of river basin commissions to develop and manage

water<sup>23</sup>;

- (d) Improve data collection and resource analysis. Data collection, monitoring and analysis by central government and state institutions need to be enhanced for better planning (including combined assessment of surface and groundwater resources and monitoring of environmental impacts, e.g., downstream hydrology, water pollution, disease incidence). Progressively shift data and monitoring responsibilities to the river basin planning commissions;
- (e) Use pricing to allocate water. To generate funds and facilitate inter-basin transfers, guide municipal and industrial use, reduce overexploitation of groundwater and electricity and, as practical, guide surface irrigation use;
- (f) Improve central coordination. Establish a senior level inter-ministerial water policy committee and combine, or at least better coordinate, the roles of CWC and CGWB; and
- (g) Amend the constitution to make water and irrigation development policy a "concurrent subject." Development of water resources would then come under both central and state jurisdiction, and no state would be in a position to apportion to itself all the water resources in its borders without the center's concurrence. Amendment may take time, but would be an important underpinning for policy and future decisions, especially over the long term. The measures above can be expedited without waiting for this adjustment.

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<sup>23</sup> The Bhakra-Beas Management Board is a useful example in this direction. It coordinates decisions among the implementing states (Punjab, Haryana and Rajasthan), and has been largely successful in this function. At least similar institutions are needed for many other major schemes as they frequently involve significant multiple use or more than one state. For instance, in the Narmada program, the present semi-autonomous institution (the Narmada Control Authority) has proven useful for inter-state coordination of planning but will need an eventual expanded role and greater authority over scheme operation and water use. Likewise, Subernarekha waters, shared among three states and with large municipal and industrial use, will require a unified implementation agency for coordinated scheme management. In cases where the scheme embraces the entire basin, the river basin commission can itself take on the implementation role.

## CHAPTER III. EXPENDITURE AND FINANCIAL MANAGEMENT

### A. Investment Focus

#### Situation and Trends

3.1 Investment in irrigation will not by itself ensure good agricultural growth. To be effective, it must be focussed on the right priorities and implemented through the right project activity. In India, scarce government resources have not been getting to the most urgent and highest-return priorities in the irrigation sector, and inadequate use is being made of private capital for irrigation development. Substantial wastage is occurring. Public investment is also under pressure as a result of declining revenues from water charges. Radical improvement in the investment focus and financial management of irrigation is required. The only tenable choice for government is to engage in a bold and rigorous effort to prioritize investment and tighten management, while at the same time, addressing key performance problems.

#### Expenditure Priorities

3.2 Government should focus expenditures on investment that will enable irrigation to make a maximum and sustainable impact on agricultural growth. Past expenditures have, in many ways, been the opposite of this. Public funding has emphasized new, long-gestation surface irrigation, and has resulted in a proliferation of incomplete schemes. More viable options, including encouragement of private investment (private rather than public tubewells, farmer rather than government construction and operation of micronetworks), have been neglected. Obvious and overriding priorities are improved water management and maintenance. Expansion of irrigated area will also be necessary to improve agricultural growth. Investments with high economic viability, productive impact in as short a time as possible, and relatively low public cost per hectare are key. Additionally, project preparation and selection must be based on broader data collection and rigorous analysis, and a pipeline of quality projects developed to ensure selectivity and more timely and better implementation. The following should be financed:

- (a) Maintenance. Maintenance cannot be neglected and must receive first call on government expenditures. The past investment in over 16 million ha of surface irrigation is increasingly falling into disrepair due to inadequate maintenance in nearly all states. Preserving the existing investment is essential or over a century of effort will return to rainfed conditions.
- (b) Productivity Improvements in Existing Schemes. The critical need is to improve deficient water management. Achieving impact as quickly as possible necessitates a low-cost approach, focussed on improved seasonal planning and operation of surface schemes, complemented by selective investment on key control structures and command communications. This can be supplemented by a more limited program to modernize selected commands, backed by technology research and initial piloting. In parallel, extension for irrigated agriculture also needs improvement.
- (c) Support private groundwater development. This has been the largest contributor to irrigation expansion and improvement over the past two decades. Scope is particularly large for further investment in eastern India. Government should enhance its support for private investment through: credit and (where justifiable) investment subsidies for poor farmers; expansion of rural electrification but concomitant removal of electricity subsidies; recharge programs for areas with falling water tables; research and promotion of energy-efficient pumps; and monitoring groundwater levels and any necessary regulatory functions.
- (d) Completion of viable, ongoing surface irrigation projects. Surface irrigation investment

should be restricted to completing the substantial backlog of incomplete projects. The government estimates that incomplete projects represent 12.5 million ha of potential and completion costs of Rs 240 billion (US\$13 billion). Although many completions will not be viable, most would involve lower incremental costs per hectare, higher viability, and shorter implementation periods than new projects.<sup>24</sup> In some states completion of the backlog would take at least a decade. No new investments should be undertaken in a state until viable ongoing projects are completed.

- (e) Support Farmer Development of Micronetworks. Investment by farmers in water courses, field channels and field drains is required on most commands, even those considered "complete" in terms of main infrastructure. The current tendency for the public sector to construct and maintain such micronetworks should be reversed. It is unaffordable and leads to perpetual reliance on the state. Improved water management to the government outlet needs to be accompanied by an upgraded technical assistance and extension service to help farmers construct, operate and maintain micronetworks, plus provision of credit and perhaps matching investment grants.
- (f) Drainage, flood control and land rehabilitation. Investment in surface drainage, previously neglected, is now needed in parts of many commands, including more expensive groundwater drainage in some areas affected by rising water tables and salinization. The potential aggregate area where surface drainage would be economically viable is some 5-10 million ha. In many areas drainage investment would have greater productive impact, and at much lower cost, than investment in surface irrigation.
- (g) Storage and river basin transfers. The above items take precedence over new irrigation schemes. However, over the longer term, investment in water storage will increasingly be required to capture seasonally concentrated rainfall and to respond to crop requirements outside the monsoon season. In some water-short areas, even now, selective new investment in storage-based irrigation, usually associated with other uses of water, is justified (e.g., the Narmada development program for western India). Also, where technically and economically viable, inter-basin water transfers serving water-short southeastern India may need to be considered.
- (h) Rehabilitation. Regrettably, reinvestment in infrastructure that has deteriorated due to poor construction and maintenance is necessary. In some states, this need will demand a major portion of public expenditures on irrigation and will reduce funds for expansion for many years to come.

### Project Preparation and Selection

3.3 Pressures to invest in irrigation have led government to sacrifice the quality of technical preparation, financing investments without full project preparation based on adequate hydrological, technical, agronomic and socioeconomic data, and without a detailed and costed component-by-component technical design. Serious deficiencies in economic evaluation and technical preparation are the cause of many of India's problems with irrigation implementation. Once priorities for investment are in place, choosing the right project is paramount. Project identification, preparation and appraisal procedures, as well as the criteria and processes used in project selection, need overhauling. Unlike industrial and other infrastructural sectors in India, where calculation of an economic rate of return (ERR) has become standard procedure, irrigation investments are evaluated

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<sup>24</sup> To sharpen the list of candidate projects subject to technical and economic viability assessment for completion of works, GOI has suggested that initial selection be confined to projects where at least 25% of intended investment has already occurred.

on the basis of undiscounted benefit/cost ratios. The cut-off benefit/cost ratio for irrigation is 1.5:1, with a ratio greater than 1:1 accepted in drought-prone areas. Prices used are financial and sensitivity analysis is rarely performed. These ratios are calculated at the end of project preparation, rather than as a decision-making aid during project identification and when evaluating design alternatives. A common practice is to ensure project acceptance by inflating benefits and underestimating costs. Despite a lengthy multi-stage clearance process, involving numerous government departments at state and central levels, scrutiny of key technical assumptions is often weak. Economic and financial evaluations are also weak, due to the critical absence in state irrigation departments and in the CWC of staff qualified in these disciplines. Finally, a serious consequence of these deficiencies is a lack of well prepared projects ready for appraisal. A pipeline of irrigation projects needs to be developed so that selection of investment will be based on quality. Then, there is need for an objective selection process, with prominence placed on economic viability.

### Actions to Improve Project Investment

The following actions are recommended:

- (a) Create a pipeline of short- and medium-term irrigation proposals, focussing on priority options identified above.
- (b) Use more rigorous guidelines for technical preparation of irrigation and drainage investments;
- (c) Revise the methodology for economic evaluation of irrigation projects based on standard discounted cost/benefit criteria (ERR or discounted net benefit/ cost ratio);
- (d) Upgrade the project preparation and appraisal capability in each state irrigation department and at the level of CWC, involving more thorough technical analysis, funding of physical and socioeconomic data collection, staff training and use of consultants;
- (e) Establish or, where existing, upgrade project monitoring and evaluation units in state irrigation departments and CWC;
- (f) Contract part of monitoring and evaluation work and impact evaluation to consultants and universities; and
- (g) Engage local and selected national universities in preparation reports and monitoring and evaluation studies, to increase the public accountability of decision-making and performance.

### B. Financial Management

3.4 Until the early 1950s, irrigation made a net positive contribution to government finances. Revenues from water charges exceeded government expenditures for operations and maintenance plus imputed interest on investment. Now the sector is a financial burden. By 1967/68, capital costs were no longer being recovered and a net annual loss of Rs 580 million was incurred (on revenues from water charges less recurrent expenditures). Deterioration accelerated in the 1980s. By 1988/89, current expenditures on operations and maintenance on major and medium irrigation projects exceeded revenues from water charges by Rs 23.5 billion.<sup>25</sup> Rural electricity subsidies, primarily for pumping water from tubewells, accounted for another Rs 14.6 billion (1986/87,

<sup>25</sup> Further, surface irrigation subsidies have been expressed here without inclusion of capital cost recovery.

current prices). Subsidies to irrigation grew by 10% per annum in the 1980s and rural electricity subsidies grew by 15% per annum. Irrigation and electricity subsidies now represent the bulk of rural subsidies in India<sup>26</sup>; in 1986/87, irrigation was 37% and electricity 27% of total rural subsidies.

3.5 In the 1980s, while current expenditures increased in real terms by 280%, revenues from water charges increased by only 29%, despite expansion of irrigated area (Table 3.1). Current expenditures for major and medium irrigation projects are now 14 times revenues, representing 6% of total state current expenditures, while water charges are 0.4% of total state revenues. At the same time, total expenditures on irrigation have shifted from capital investment (irrigation expansion) to recurrent costs. In 1980/81, 78% of expenditures went to investments; by 1988/89, the share of investments had fallen to 55%.<sup>27</sup> Costs per hectare irrigated for new irrigation have also mounted.

Table 3.1: Revenues and Expenditures On  
Major & Medium Irrigation Projects

	(Rs Billion in 1980/81 Prices)	
	<u>1980/81</u>	<u>1988/89</u>
Current Revenues (water charges)	0.9	1.1 (+29%) <sup>2/</sup>
Current Expenditures (non-Plan)	3.9	15.0 (+280%) <sup>2/</sup>
Capital Expenditures (Plan disbursements)	14.0	18.3 (+31%) <sup>2/</sup>
Current Revenues as % of Current Expenditures	22%	7.5%
Capital (Plan) outlays as % of Total Expenditures (Plan and non-Plan)	78%	55%

<sup>2/</sup> Percent increase of 1988/89 over 1980/81.

Source: Adapted from Reserve Bank of India Bulletins.

3.6 Rising Current Expenditures. The steep rise in current expenditures has been primarily due to growth in irrigation department wage bills, mostly due to burgeoning staff numbers. Standard state data do not systemically disaggregate non-Plan expenditures into component parts (staff numbers, wage increases, works, etc.), but data from individual studies in selected states and commands may illustrate the situation applicable in varying degree in nearly all states. In some states and commands analyzed, current expenditures in the early 1980s more than doubled in four

<sup>26</sup> Source: "Agriculture: Challenges and Opportunities" (India 1991 Country Economic Memorandum, Agriculture Operations Division, India Department, World Bank).

<sup>27</sup> Financing in India is subdivided between "Plan" funding and "non-Plan" funding. Plan funds are for investment purposes (new investments, completion of ongoing investments, rehabilitation, etc.), while non-plan funds go to current expenditures such as, in irrigation, operations and maintenance including staff salaries. Plan funds allocated in the states have two components; funds allocated to the states by central government including foreign aid contributions, and funds originating from state exchequer. The center also makes general financial allocations to the states which supplements state non-Plan expenditures. Except where otherwise indicated, current expenditures in irrigation refer to non-Plan funds, and investment or capital expenditures refer to Plan funds from both central and state resources. Irrigation sector revenues refer to direct revenues from irrigation in the form of water charges paid by farmers (where reference is made to groundwater irrigation, electricity tariffs are also relevant).

years, almost entirely due to increasing staff costs.<sup>28</sup>

**3.7 Inadequate Funding of Maintenance.** Little productive impact has been achieved from the escalation of current expenditures. Instead of improving operations and maintenance, urgently needed in most states, staff numbers and wage bills have absorbed most incremental expenditure. Even in Punjab, where maintenance has been comparatively good, an average of 85% of the non-Plan irrigation budget between 1986 and 1989 was spent on salaries and wages, and in the same period identifiable expenditures on maintenance decreased by 40%.

**3.8 Increasing Investment Costs.** Comparing the Fifth (1974-79) and Sixth (1980-85) Plans, investment costs per hectare increased by 57% in real terms.<sup>29</sup> Based on documented project experience, this trend probably continued over the past five years. Part of the increase reflects the higher cost of progressively more difficult project options over time, but this hardly explains the increase in so short a time. Further examination is required. Likely causes are laxity in contracting and supervision of construction, and inadequate systems for monitoring, cost analysis and control of expenditures.

**3.9 Declining Revenues from Irrigation.** Water charges are the main direct source of revenues from the irrigation sector. For surface schemes, these are levied annually on a per hectare-crop basis, with rates depending on crop and season. Rates are generally higher for more water-intensive crops and in seasons when irrigation water is more scarce. For electric tubewells, an annual fixed charge per unit of horsepower is applied. Water charges vary considerably across states, as do collection rates.<sup>30</sup> The slow growth of revenues from water charges reflects their infrequent revision, resulting in erosion of real values over time. Water charges have not been changed since the mid-1980s in most states and not since the mid-1970s in Punjab, Haryana, West Bengal and Tamil Nadu. Compounding the problem, collection rates have declined in a number of states, especially in the last several years.

#### Actions to Improve Financial Management

**3.10** The origins of financial problems in the irrigation sector are weak financial management and monitoring at the state level. Political and corruptive pressures perpetuate the situation. In most states, no meaningful financial analysis, planning and monitoring are undertaken.<sup>31</sup> Irrigation departments seldom contain financial analysts and there is little cost-accounting to probe what is happening to expenditures.<sup>32</sup> Management information systems, where present, do not

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<sup>28</sup> See analysis in Vol. II, Chapter V. An extreme situation is found in Bihar where establishment (personnel) costs increased by 148% in only four years (1980-81 to 1984-85) while expenditures on works related to maintenance declined slightly in the same period. The growth of establishment costs in Bihar was influenced both by a doubling of the costs of the revenues establishment (personnel involved with collection of water charges) and by a 2.6 fold increase in the costs for operation and maintenance staff.

<sup>29</sup> Average for 14 states based on New Concept Consultancy Services (1989) and Ravishankar (1990).

<sup>30</sup> The collection rate is the actual money collected expressed as a percentage of the money due based on existing water charge levels and irrigated area.

<sup>31</sup> Even past review procedures have slipped. The former Irrigation Administration Review, an annual report on each surface scheme, has fallen into disuse.

<sup>32</sup> Some useful initiatives are now being taken. In Orissa, the irrigation department has obtained agreement from the state budgeting authorities to have a budgetary sub-heading for "staff" (previously grouped with "works") in the O&M budget. This will limit line managers (e.g., executive engineers) to keeping staffing within

usually generate useful and timely data for decision-making. Availability of data on staff levels and expenditures, unit costs and cost-recovery over time is scanty, and usually out-dated. Verifying expenditures is also difficult because desk audits do not check financial statements against field actions and materials used, a difficult task with dispersed field operations.

3.11 Substantial improvement in sectoral efficiency can be made if these issues are tackled. Conversely, without action, the sector's drain on public resources may soon reach unsustainable proportions, a situation nearly at hand in some states.

3.12 To be effective, strong political support is necessary from state leadership in providing back-up to state irrigation and finance departments, and in creating a supportive environment for change.

Recommended actions at the state level are:

- (a) Implement an interim action program. A quick diagnostic analysis of irrigation expenditures by component over time should be undertaken by each state. This should include comparison of achievements based on physical indicators against expenditures. The review should focus on evolution of staff numbers and the wage bill; costs per unit of infrastructure constructed or under operation; and maintenance needs compared with actual expenditure on maintenance. Even with the limited data available, key problems and needs in any state are readily identifiable. Based on this diagnosis, an interim action program should be drawn up and implemented to tackle the most critical deficiencies: halting growth in staff numbers, providing adequate funding of maintenance, and controlling construction costs. More detailed and fundamental follow-up can occur over time.
- (b) Initiate cost-accounting and develop financial management skills. Staff capabilities, mechanisms for collection and analysis of data, and management reporting procedures need to be established for each command and at ID headquarters. This would provide the management information system required for taking actions to improve the efficiency of expenditures by operation (e.g., staff versus works expenditures, breakdown of materials used and costs, comparative costing on a per-hectare or kilometer-of-canal basis). Consultant assistance will usually be necessary to help establish the MIS.
- (c) Control Staff Numbers. A state plan to reduce irrigation sector staff numbers, or at least halt further growth, should be drawn up and implemented (See Chapter V for alternatives to expanded government personnel in irrigation).
- (d) Plan and fund maintenance fully. Detailed state irrigation maintenance plans and budgets following a standard format should be prepared annually. Maintenance expenditures corresponding to the budget should receive top funding priority rather than the present last priority. Maintenance should be closely monitored, both in terms of financial allocations and field actions.<sup>33</sup>

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the budget for staff and protect expenditures on materials.

<sup>33</sup> Cost norms per hectare have been prepared in the past by CWC to guide funding decisions for maintenance. Actual allocations by state governments towards maintenance have usually been well below the norms because of absorption of funding by salaries and wages. Some observers have also criticized the norms for being too low or not adequately tailored to the specific conditions of particular states and commands. In the future, while cost norms may provide some general guidance, a better procedure would be to rely on the specific maintenance plans and

- (e) Monitor and control construction quality and costs. The MIS should include analysis of construction costs over time and in different commands, and information relevant to the program for improving construction quality as discussed in Chapter IV.
- (f) Prepare financial reports. Each ID should prepare an annual irrigation sector financial report, following a standard format and including analysis relevant to the points above. The financial report would be used by state governments for annual review of irrigation performance, for establishing improvement objectives, and in preparing and approving the budget and development targets for the forthcoming year.

### Cost Recovery Policy and Procedures

3.13 The low level and poor collection of water charges has been a persistent and intractable issue affecting nearly all irrigation in India.<sup>34</sup> Technical and administrative reasons behind low cost recovery include the poor service provided on many irrigation commands (resulting in low-income improvements and leading farmers to consider that they have no obligation to pay) and poor assessment and collection procedures. The politicization of water charges, with politicians frequently promising not to increase rates or forgiveness of non-payment, has been a major factor behind both the minimal changes in water charges over time and in the low collection, even of assessed rates.

3.14 Irrigation Charges. While GOI's National Water Policy calls for improvement of cost recovery,<sup>35</sup> commitment varies within central government and across states. A frequent justification for low cost recovery is that indirect revenues from irrigated agriculture probably exceed the current cost of operating and maintaining irrigation and, in the case of tubewells, subsidies on electricity.<sup>36</sup> This is the case in an agricultural surplus state (Punjab) and may be so, but marginally, in poorer states (Bhatia, 1989). But, India is not in a position where it can afford to forego revenues from productive services that directly increase the incomes of beneficiaries. Further, inadequate charging runs counter to equity concerns. Under good irrigation, farmers gain substantial economic rent from the irrigation service. Water and electricity charges provide a direct way of charging beneficiaries for a service which directly benefits them, whereas indirect taxes also tax non-beneficiaries.<sup>37</sup> Irrigation provides farmers with private benefits, and the service should accordingly be paid for. This also conveys legitimacy to farmers' demands for a quality service from irrigation managers and will form the basis for eventual financial autonomy of surface irrigation commands (Chapter V).

3.15 Charging According to Usage. As elsewhere in the world, "efficiency pricing" of water (equating marginal costs with marginal value product to achieve optimal allocation) has limited

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budgets of each state.

<sup>34</sup> See Vol. II, Chapter V for more detailed analysis and discussion of cost recovery.

<sup>35</sup> "Water rates should be such as to convey the scarcity value of the resources to the users and to foster the motivation for economy in water use. They should be adequate to cover the annual maintenance and operation charges and a part of the fixed costs. Efforts should be made to reach this ideal over a period, while ensuring the assured and timely supplies of irrigation water." (National Water Policy Paper, 1987).

<sup>36</sup> "Indirect revenues" include agricultural market taxes in various forms (e.g., market yard taxes, "mandi" charges and benefit levies), consumption goods taxes, and taxes on incomes of workers employed as a result of the secondary and tertiary employment impact of irrigation.

<sup>37</sup> While agricultural market charges may be a proxy for water charges (marketed output is often from irrigated holdings), surplus producing rainfed farmers are also taxed, which is inequitable.

scope for application in India. The marginal value of water is high during critical periods and changes unpredictably throughout the season. Nevertheless, both water charges and electricity are currently priced at flat rates and greater efficiency in the use of both, in association with better environmental control, could be achieved by charging variable rates, even where below marginal value. This is evidenced in water-use economy by farmers using diesel pumpsets for irrigation and incurring fuel cost for each liter of water. Practical application for other types of irrigation is difficult. For supply-based systems such as warabandi it has no relevance. For other surface systems, measuring water use by individual farmer is impossible. One adaptation being piloted in Maharashtra<sup>38</sup> is to charge volumetrically at the level of a minor, leaving a farmers' group to organize collection of revenues among member families. Such possibilities merit further piloting but would take time to replicate; at present, even assuring water to minors is difficult and minor head structures do not have volumetric measuring devices. Possibilities for charging variable rates are greater for electricity, as electricity metering is technically easier and is common practice in other countries.

3.16 Affordability to Farmers. Farmers can afford water and electricity charges, except in the case of crop failure or where the irrigation service conveys minimal benefits. Present charges are far from excessive; typically less than 2% of the value of crop yields and less than 4% of the net additional returns (economic rent) that farmers receive due to irrigation. In most cases, water charges covering the full costs of effective operations and maintenance are affordable.

3.17 In contrast to O&M, the recovery of capital costs may not be possible. While analysis shows that a proportion of capital costs can reasonably be charged for (Vol. II, Chapter V), full recovery requires good incremental production from irrigation, a situation frequently not found, as reflected in economic returns from past irrigation schemes. It should probably be accepted that full recovery of capital investment in most large-scale surface irrigation schemes is unattainable. However, it is important that farmers make some contribution to these investments so that a sense of ownership, participation and responsibility is created. To do so it is recommended that: (i) a nominal charge be imposed on farmers to cover a portion of capital amortization of the main system to the government outlet; and (ii) construction of micronetworks be assumed by farmers, using their own resources (with credit provisions as necessary).

### Actions to Improve Cost Recovery.

3.18 GOI's longstanding principle of charging for water and electricity at levels at least equal to the cost of operations and maintenance is strongly supported. Clearly, major improvements are needed in its application. GOI should also monitor the performance and reporting of cost recovery and its impact on the overall financial situation of state irrigation sectors. Water charges should continue to be set at the state level, with increasing application within each state of water charges by individual command. Recommended actions are:

- (a) Set charges at least to cover the costs of effective operations and maintenance in a normal command. "Effective" O&M also covers a nominal share of ID overheads, but excludes excessive state expenditures on wage bills, unproductive expenditures, and rehabilitation costs. Actual O&M costs will vary by command, depending on equipment and service and state of repair. A distinction is needed between costs for rehabilitation and O&M costs for a "normal" command in reasonable repair. In most situations, water charges could also be set without hardship to farmers at levels that would partly recover capital costs. This would be desirable, though full coverage of normal O&M costs would itself represent a major achievement.
- (b) Introduce water charges specific to an individual command. Higher water charges,

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<sup>38</sup> Majalgaon command under the Maharashtra Water Utilization Project (Cr. 1383/Ln. 2308).

including at least part of capital amortization, could be applied following agreement with farmers prior to an investment. The appropriate moment to levy such charges would be at the time of commissioning a command or completing rehabilitation works or water management improvement. A further step -- retention of water charge revenues at command level accompanied by a phasing out of government funding for O&M -- could set the stage for eventual financial and administrative autonomy of individual commands.

- (c) Delink maintenance from cost recovery performance. Adequate financing of maintenance is an essential requirement in itself, regardless of the status of cost recovery. Further, water charges go into general state revenues and are not directly linked to expenditures on O&M. O&M costs are a logical guideline for cost recovery (the budgetary impact of current expenditures is neutralized), but in situations of poor recovery, maintenance should not be scapegoated. The effect has been inadequate funding for maintenance, based on the excuse of insufficient revenues from water charges to cover these expenditures.
- (d) Reassess water charges annually. There is no regular mechanism for setting the levels of water charges nor analytical guidance for their assessment. IDs make occasional proposals regarding water charges largely on political grounds. Automatic annual review of water charges should be initiated, based on analysis by a small unit within the irrigation or finance departments, guided by a committee of government representatives (finance, planning, irrigation, and agriculture), and farmers. Clear guidelines for the review would include estimates of O&M expenditures, recurrent expenditure on irrigation, the record of water charges received and collection rates achieved, and an analytical overview of the costs and revenues from irrigation and well electrification, and the implications for the state exchequer of the subsidies involved.<sup>39</sup>
- (e) Reduce Government Involvement in Collection. The heavy government apparatus involved with collection of water charges from individual farmers in many states should be disbanded in favor of using local communities, such as village panchayats or water-user associations (WUAs). In Bihar, the costs of collection are greater than the revenues received (Bhatia, 1989) and this situation is likely in several other states. By contrast, a high collection rate is achieved in Punjab at low administrative cost, using village revenue officials who retain a small percentage of revenues as an incentive. There is also a need to simplify administration of collection. An option for government is to charge each WUA or panchayat an annual fee based on a flat rate per net hectare irrigated. The panchayat or WUA would be left to make its own decisions and arrangements concerning payments by individual farmers and variable charges by crop or water used. Overall responsibility for collection of water charges from these organizations would be best under the district collector (who has responsibility for other revenues) rather than, as found in some states, under the irrigation department, which should focus on providing the irrigation service.
- (f) Remove the electric power subsidy. The subsidy on electric power for tubewells should be removed.<sup>40</sup> Farmers with wells powered by electric motors pay a flat annual rate based on the horsepower of their pump. These rates involve substantial subsidies.

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<sup>39</sup> A proforma report should be drawn up to assist states in modelling their analysis; perhaps jointly by CWC (which has been monitoring cost recovery for some time) and the Ministry of Finance, in collaboration with state governments and financial consultants.

<sup>40</sup> See analysis in "Uttar Pradesh Groundwater Development, Issues and Options" (India Agriculture Operations Division, World Bank, February, 1991).

for example, 60% on a typical shallow tubewell in Uttar Pradesh (over 75% for more intensive usage). Removal of the subsidy is easily affordable, as farmers get high returns from tubewells, even with diesel pumps, where largely unsubsidized fuel results in a five-fold increase in operating costs, compared with electric pumps. Subsidies for public tubewells (per hectare and, in particular, per unit of water used) are even larger than for shallow electric tubewells. Public tubewells in Uttar Pradesh, for instance, involve complete subsidy for capital costs, maintenance and government management, plus, at current estimated collection rates, over 95% of the cost of electricity.<sup>41</sup>

- (g) Implement a variable-cost system for electricity. Previously standard practice in India, a variable-cost system was abandoned due to widespread malpractices. However, the absence of meter-based pricing is causing excessive and indiscriminate use of power, providing minimal incentives to farmers and pump manufacturers to use and manufacture efficient pumps, and is encouraging over-exploitation of groundwater. Full cost meter-based pricing is an important underlying basis for successful groundwater development and exploitation, in many states the principal remaining source of productivity growth through irrigation. It would also have a large beneficial fiscal impact. Consideration of how to achieve this objective is warranted.<sup>42</sup>

### C. Funding Conditions by Central Government

3.19 Central government monitoring of financial management and performance at the state level is also inadequate, starting with limitations imposed by data quality from state governments. Although the ability to conduct strong financial analysis is present in the Ministry of Finance, Reserve Bank of India and Planning Commission, this skill is less present in the Ministry of Water Resources and CWC, both dominated by engineers. Despite their joint concerns, central government funds are allocated to irrigation programs with minimal conditionality. Their influence on state expenditures and financial management is scant.

### Efficiency, Maintenance, and Cost Recovery

3.20 Demonstrated progress in efficiency of expenditure and financial management should be a condition of allocation of Plan funds to the states' irrigation investment programs. GOI will need to improve its capabilities for physical and financial monitoring of irrigation programs in the states. Existing commissions (Planning and Finance) should tighten their review role with enhanced monitoring inputs from MOWR and CWC. At minimum, GOI should monitor three measures by each state government to achieve: a) improved financial management; b) full funding of maintenance; and c) cost recovery. Progress would be jointly reviewed by GOI and each state government annually prior to disbursement of Plan allocations for irrigation investment:

- (a) Expenditure Efficiency and Financial Management. Joint review by GOI and each state government of the proposed financial report on the state's irrigation sector (para 3.12d) would foster a continuing process of improvement in financial management and efficiency of expenditures. The financial report would include standard review of

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<sup>41</sup> The ID provides payments to the state electricity board, but this is merely a transfer payment from one government department to another. The actual subsidy is the full cost of providing power less the revenues received from farmers.

<sup>42</sup> One way is to charge a high flat rate in the absence of a meter or where a meter is malfunctioning so that this situation would involve payments well in excess of the rate charged even under intensive use with a meter. Village officials could be responsible for collection, retaining a portion of charges as an incentive, and backed by both electricity board and independent monitoring.

physical achievements and expenditures against targets, analytical breakdown of key expenditures (maintenance, operations, staff numbers, staff costs, and unit costs by investment category) and diagnosis and proposed action to tackle identified problems. State governments should also make these reports public to foster greater accountability of IDs to users.

- (b) Maintenance. Inadequate funding of maintenance should be sufficient grounds for not allocating central Plan funds for irrigation development to an individual state. GOI should scrutinize each state's annual maintenance plan and budget (para 3.12e), including field visits by CWC staff, ex-post review of the preceding year's maintenance plan and actual expenditure on maintenance, and review by finance committees of the adequacy of the maintenance plan and budget for the forthcoming year. Good maintenance, including full funding for this purpose, would be expected. For those states encountering budgetary difficulties in meeting needs for maintenance expenditure, despite improved financial management of irrigation, GOI could consider allocation of Plan funds for maintenance on the basis of the state's detailed maintenance budget and implementation program.
- (c) Cost Recovery. Analysis, prepared by the state cost-recovery committee (para 3.18d), of its cost-recovery situation, the total subsidy involved, achievements in the past year and recommendations for the forthcoming year should also be annually monitored by GOI. Desirable features would be quality analysis and wide dissemination of its findings to senior government officials and the political establishment to promote clearer understanding of the fiscal consequences of poor cost recovery and the opportunity to focus on these issues annually, thereby encouraging decisions to implement improvements. The objective would not be to insist on full recovery of O&M costs as a condition for allocation of central Plan funds. While desirable, full O&M cost recovery may not be fully achievable politically in some states in the short run. Cost-recovery performance should, however, enter into judgment of a state's financial solvency and of its capacity for further investment to expand irrigation.

## CHAPTER IV. TECHNICAL PERFORMANCE

### A. Productivity

4.1 The productivity of Indian irrigation is below, in some cases half, the levels attained in other large Asian countries and elsewhere. For example, irrigated paddy yields average 2.5t/ha in India, compared to 5.5t/ha in China and 4.1t/ha in Indonesia. While care must be used in drawing conclusions from such comparisons (conditions and, in particular, water availability are not the same), they indicate major scope for improvement.<sup>43</sup> Irrigation intensity of 1.29 is also low. Additionally, many surface irrigation systems have restricted capacity to enable crop diversification. Without increased yields, cropping intensity, and agricultural diversification, prospects for increased agricultural growth and rural socioeconomic development will be severely limited.

### Water Management

4.2 Deficient water management is a widespread problem on some 10-13 million ha of irrigated land (about 55-75% of India's net surface irrigated area) that are performing below potential. Very large gains in agricultural productivity can be achieved if water management on these existing irrigation schemes can be improved, and some additional increase in productivity can also be achieved on most of the remaining irrigated area. The most important component for improving productivity of irrigation is better water management, accompanied by upgraded agricultural extension, research, and irrigation technology.

### Water Distribution Systems

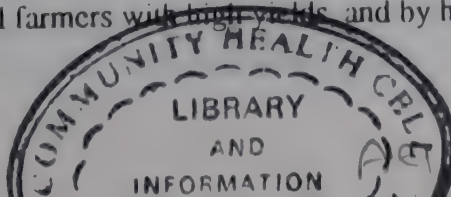
4.3 On most surface commands, water is poorly distributed over area and time. A common shortcoming is that tail-enders are not getting water or are getting insufficient and unreliable water. Conversely, head-enders often get too much water, either because they have no choice (for instance, fields situated near leaking canals or outlets) or by choice, taking water when they can and often more than needed. Also, many farmers have limited knowledge of crop water requirements and detrimentally over-water their crops, even when irrigation water will be available later. Further, the seasonal nature of river flows, compounded by design and water management deficiencies, frequently means that irrigation is only available during and shortly after the monsoon, diminishing possibilities for rabi and summer crops.

4.4 Although the nature and extent of these problems vary widely, they have important impact on agricultural productivity. Where irrigated water is not getting to farmers, production is restricted to rainfed conditions; where land is getting too much water, waterlogging results, reducing yields and causing water table build-up, and eventually salinization. The most pervasive and frequently underestimated situation is where farmers are getting water but in unreliable or poorly timed amounts. Intensification is hobbled; farmers choose low-risk agricultural options: more robust basic cereal crops, hardier but lower yielding traditional varieties, limited fertilizer application, and surer but lower yielding cropping calendars, such as planting after the monsoon begins. Scope for crop diversification is also limited.

4.5 For surface irrigation, regional performance is linked to type of irrigation system, agoclimatic and socioeconomic conditions, as well as design, infrastructure and management on individual commands. The main types of schemes in India are:

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<sup>43</sup> This is confirmed by the large gap noted by Indian researchers between research yields and farmer yields, by the presence throughout India of individual farmers with high yields, and by high average yields on commands in India where irrigation has been successful.



- (a) the warabandi system of semi-arid to arid northwest India, where irrigation water is rationed strictly in proportion to farm area and supplied on a predetermined rotational schedule. Farmers decide on crops according to the expected water supply. Infrastructure and operational procedures are relatively uncomplicated;
- (b) the shejpali systems of western and parts of central and southern India, where farmers obtain official sanction, usually annually, for proposed cropping patterns and are then entitled to irrigation supplies according to crop needs. Designed at a time when irrigation water was plentiful relative to demand, most shejpali systems are now experiencing difficulties;
- (c) the localization systems in parts of southern India, focussing on locational control of cropping patterns. Low-lying areas are zoned for "wet" crops (primarily rice and sugarcane), while higher areas are limited to irrigated "dry" crops and more restricted water supplies. Such zoning often breaks down as head-end farmers in "dry" zones take more than their theoretical allocation; and
- (d) traditional field-to-field irrigation systems used mainly for rice in parts of eastern India and some delta schemes in the south. Continuous irrigation flows are provided, passing from field to field, generally without water courses and field channels. Operating rules have often evolved and been agreed through local tradition, and where water is abundant, yields can be good. However, crop choice and cropping patterns are limited.

4.6 A broad distinction can be made between supply-based or "crop-to-water" systems that distribute water according to predetermined procedures and require the farmer to respond accordingly (such as warabandi) and demand-based or "water-to-crop" systems that attempt to meet crop needs (such as shejpali). In supply-based systems, the role of the irrigation department tends to be simpler than under demand-based systems that require the department to respond to changing farmer needs with more complex and flexible infrastructure and more intensive management. No system is completely demand- or supply-based; rather, the terms capture the tradeoffs between responsiveness and management complexity.

#### Water Management by Region

4.7 Northwest India. In the northwest, a good fit has been achieved between agroclimatic and socioeconomic conditions and irrigation system, and management performance is generally good to excellent. The average irrigated cereal yield of 3t/ha in Punjab is the highest in India, and probably compares well with yields in other countries if yields are expressed per unit of water used rather than on a per hectare basis.

4.8 Favorable conditions play a large role in the success of the supply-based warabandi system. River flows, fed by Himalayan snow melt from March through October as well as by monsoon rains, provide perennial and fairly reliable flows for the largely run-of-the-river diversions for irrigation. With rainfall limited and irrigation as the most reliable source of water, even in the monsoon, farmers plan on the basis of expected and reliable irrigation supplies rather than rainfall. This limits the stresses that could result from farmer reactions to unreliable rains (para 4.10). Further, due to unfragmented holdings, farmers have flexibility to allocate their water ration within their holdings, enabling some degree of crop choice and good use of available water. Also importantly, the Indo-Gangetic plain aquifer provides ready availability of groundwater for supplementing surface irrigation supplies. Farmer investment in tubewells has grown enormously

in the northwest since the 1960s and has provided a major boost to agricultural productivity.<sup>44</sup> Access to groundwater compensates for warabandi's limitations in responding to specific water needs and timing of increasingly water-intensive and diverse cropping choices. Higher literacy levels, strong and generally cohesive village community structures, prevalence of land ownership rather than feudal tenancy arrangements, and better availability of transport infrastructure, agricultural support services and inputs also play a role.

4.9 Eastern and Central. Despite higher rainfall, yields, irrigation intensity and possibilities for diversification are poor in eastern and central India, and the difference between rainfed and irrigated yields is often small. Typically, surface irrigation is supplied through run-of-the-river systems, dependent on rainfall, and usually is only available after the advent of the monsoon, when the problem is often excessive rather than insufficient water. Where well managed, the surface systems could at least provide protective irrigation during dry periods for the kharif crop. But even this limited function encounters major difficulties: farmers' reactions to lack of timely water, design deficiencies, broken infrastructure and poor operational management.<sup>45</sup>

4.10 Attempts to introduce warabandi in eastern and central India have mostly been unsuccessful. Recent analysis (Berkoff, 1990<sup>46</sup>) illuminates the influence of rainfall on managing irrigation in eastern India and its easier management in the northwest. Rainfall in the Indo-Gangetic plain increases from west to east, and under conditions of higher rainfall (central Uttar Pradesh eastward) all farmers, hoping for sufficient rainfall, plant their entire land to a kharif crop. When a dry interval occurs, however, all farmers need irrigation water on their entire parcels to avoid crop failure. Tremendous stresses arise: head-enders will experience crop failure if they do not take more than their due; tail-enders are deprived of their water and lose their crop. Conflicts arise and breakages by farmers of irrigation structures are common. By contrast, in the northwest, farmers plan on irrigation water as their regular water source, with monsoon showers an expected but unpredictable bonus. Farmers limit water-sensitive crops to perhaps 20-30% of each farm (more, with access to groundwater), with the balance under scratch crops, fodder or fallow. If one takes surface irrigation water out of turn, a specific neighbor's loss (failure of his high-value crop) is greater than the abuser's gain (a marginal increase in a crop that would survive anyway). The system tends to be self-policing and stable, with relatively little farmer interference or damage.

4.11 Peninsular (south and west) India. The performance of surface irrigation schemes in peninsular India is diverse. Management of demand-based systems has often proven difficult under the stresses of different cropping patterns, unpredictable rainfall, more variable topography and soils, and illicit taking of water by head-enders, as well as weak design, inadequate seasonal planning, and poor irrigation management. As in eastern India, breakages of structures, minors and water courses by frustrated farmers is a common problem. Other commands have good yields due to sound design and management and the usual presence of ample water. Higher yields per hectare than in the northwest are obtained in some commands (e.g., Cumbum Valley, Periyar Vaigai and Bhadhra). Where water is ample, average paddy yields of over 6t/ha are found. However, irrigation effectiveness is lower in terms of yield per unit of water. In peninsular India, rainfed agriculture prevails, but part could also be irrigated if irrigation water was more broadly distributed to support less water-demanding crops.

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<sup>44</sup> In Punjab, the number of diesel-powered pumps alone rose from 29,000 in 1968/69 to 263,000 in 1979/80.

<sup>45</sup> Other factors are complex socioeconomic conditions, prevalence of small and fragmented subsistence holdings often under sharecropping systems, and weak institutions, commercial development and infrastructure.

<sup>46</sup> "Irrigation Management on the Indo-Gangetic Plain," J. Berkoff, 1990 (Irrigation Sector Review Background Paper and since published as World Bank Technical Paper No. 129).

4.12 Groundwater Irrigation throughout India. Groundwater irrigation with private tubewells and dugwells generally demonstrates high yields throughout India, mainly due to control by the individual farmer over timing and quantity of water. Conjunctive use of groundwater with surface irrigation has proven effective in making up for the limitations in this regard of surface schemes, providing that surface irrigation supplies are not too far out of tune with crop requirements. As a sole source of irrigation, groundwater has also been effective in areas with good aquifers. Farmers in parts of peninsular and central India are beginning to adopt drip irrigation, usually from groundwater sources, for more intensive production of fruits and vegetables.

### Water Management Issues

4.13 Debate about the merits of different regional irrigation systems has detracted from the more practical consideration of how to improve irrigation performance at the specific command level. The goal is to enhance productivity, using water, a scarce resource, as efficiently and effectively as possible. Each command is different; hence, improving water management requires individual diagnosis and subsequent actions. This procedure, rather than application of a standard blueprint, is a preferable approach. Nevertheless, a number of basic issues need to be addressed, with varying degrees of relevance, depending on the irrigation distribution system and regional characteristics.

4.14 Level of Service and Responsiveness. A basic issue is to decide on the irrigation service's degree of responsiveness to rainfall and specific crop needs. As rainfall becomes important relative to irrigation, there is a greater need for responsiveness to rainfall. The needs of individual farmers also differ, but design and management to fully achieve this would be very complex, and compromises are demanded in practice. Simplifying design and management to the point where there is little or no response to rainfall or the needs of individual farmers also has its limit; it may serve no one well, unless other features such as groundwater provide the flexibility that a surface scheme does not provide.

4.15 Of necessity there is a trade-off between the concepts of: (a) low response-low management (for instance, supply-based warabandi designed to be simple to operate and have lower needs for control infrastructure and management staffing, but offer little or no responsiveness to rainfall and varying locational and farmer needs); and (b) high response-high management (schemes that provide greater responsiveness based on more control structures and more complicated management). Low-response systems are more manageable in a technical sense, but where local conditions require flexibility, can result in farmer frustration and interference. Where responsiveness to at least rainfall becomes relevant, systems designed for greater flexibility may be necessary.

4.16 Where feasible, it is cheaper and managerially easier to opt for simplicity and options nearer to the low-response system. Yet, a variety of more responsive options exist, if necessary, for local conditions. For example, under the Sardar Sarovar project, irrigation water in Gujarat will be essentially supply-based, but a quick-response, remote-control system will respond to rainfall variations at the block level (500 ha). In the western United States, "modified demand systems" are practiced whereby farmers can purchase water up to certain limits that are adjusted when water is scarce according to pre-agreed rules. This concept might be feasible in India to the level of a minor under farmer management. Experimentation is underway in Maharashtra (Majalgaon Command<sup>47</sup>) to develop a "bulk volumetric distribution system" managed by a farmer group.

4.17 Modernization Options. India could benefit from modernization options being applied elsewhere. Relevant options include systems to provide better hydraulic stability, automated water control, and higher water-use efficiency. They do not necessarily require greater managerial

<sup>47</sup> Under the Maharashtra Composite Irrigation III Project (Cr. 1621).

sophistication, though they would require more numerous and more sophisticated water control structures (Plusquellec, 1990). A recent case study on Maharashtra (Baudelaire, 1990) estimates that a more precise and responsive system with incremental investment costs of 10-15% might enable substantial gains in productivity. Features that would reduce the need for incremental management were also considered possible. Little experience is actually available in India on such options. Nevertheless, examples of successful experimentation and practical application elsewhere, and the evident need to improve water management in India, point to the need to do further applied research and piloting for innovative water management systems.

4.18 Irrigation Research. Applied and operational research on irrigation and drainage is lagging in India. This partly explains the limited application of new technologies in widespread practice elsewhere. More applied research and pilot efforts are needed on mechanisms to improve water management maintenance, drainage (including salinity and sodicity control) and the environment. Continued adaptive research is needed on construction matters (materials research and testing, canal linings and seepage). In addition to technical research, more piloting efforts and case studies are needed to support social and organizational innovations in irrigation (for instance, in development of water-user associations and involvement of women).

4.19 Many institutions are involved with irrigation research; state engineering research institutions, state Water and Land Management Institutes, national institutes such as the National Institute of Hydrology, a variety of project-specific research programs, related research done by agricultural universities, and central institutions such as the CWC, CGWB, and Central Board for Irrigation and Power (CBIP). Given India's diversity and the need for locally responsive research, this array is probably necessary. Efforts, however, are disparate and sometimes duplicative. Networking and information transfer systems are useful functions, in part filled by CBIP which disseminates research results across states and encourages interstate linkages. Large gains could be achieved though budgeting more informational exchange with other countries on research, technology and irrigation management. Study tours, sabbaticals for research or university study, and operational secondments should also be funded.

4.20 India is currently considering a more intensified irrigation and drainage research program in cooperation with the International Commission on Irrigation and Drainage with support from the World Bank. In addition, government funding of research and related training and dissemination at state, national and international levels should be increased, and an institutional mechanism developed for the sharing of ideas and the programming and funding of priorities. This should include linkage with private sector and NGO initiatives. For instance, rapid development of drip irrigation for intensive horticultural production in peninsular India has been stimulated by research, demonstrations and extension by equipment manufacturers.

4.21 Agricultural Extension. To realize the full benefits of irrigation investment, agricultural extension and other support services need considerable improvement. Field observations indicate that on most commands extension impact is still weak; many farmers are insufficiently aware of optimal water use and fertilizer application, trace element requirements, planting density and time of planting. On commands where extension services are high-quality, better agricultural practices are observable. Knowledge of optimal water requirements is particularly weak, as neither irrigation nor agricultural extension services provide such advice. Farmers tend to overwater crops if they have access, with detrimental yield and environmental consequences, partly due to risk-avoidance but also to limited knowledge of best practice.

#### Actions to Improve Water Management

4.22 The first priority is to implement widespread and fairly rapid improvements in water management. Given the vast irrigation area, improvements must be low-cost. This requires emphasizing water operation planning and daily management, supplemented by low-cost

infrastructural improvements to facilitate better control of water. Recommended actions are to:

- (a) Implement improved water operation plans and daily management
- (b) Implement low-cost infrastructural improvements to facilitate better control of water.
- (c) Selectively opt for higher-cost infrastructural improvements. To the extent that funds are available, more costly infrastructure for more intensive water management to achieve greater responsiveness to rainfall and farmer conditions would improve productivity. Limited experience to date in India with such irrigation systems would require stepped up applied research and piloting. In the short term, such a program would be limited in extent both by the need for piloting and by funding limitations.
- (d) Step-up applied research, networking and piloting of irrigation technology.
- (e) Emphasize agricultural extension on optimal water usage. General agricultural extension also requires improvement on many commands.

4.23 The National Water Management Project. The National Water Management Project (NWMP, Cr. 1770), is piloting the implementation of some of these priorities. The project aims at helping participating states to manage existing irrigation schemes better, specifically by improving the capacity to plan, implement and monitor operations on selected commands and by funding associated low-cost infrastructural improvements. The project uses a command-by-command approach, involving a process of diagnosis, prognosis and remedial action. At scheme level it involves the following steps.

Diagnostic. A command-specific diagnosis is made of current operations, the water needs of farmers, and deficiencies relative to these needs.

Operation Plan. A prognostic program for improving scheme management and implementing low-cost infrastructural responses to identified needs. The central element is an "operation plan" on how the scheme is to operate through the year and to adapt to contingencies such as droughts or floods.

Infrastructural Improvements. An average upper limit of Rs 4000/ha (about US\$ 200) is budgeted for infrastructural improvements, generally confined to repairing or adding control structures in the conveyance system and providing communications and monitoring equipment.

Managerial Improvements. Adaptations in scheme management generally require staff training, adjustment of staff activities, mechanisms for better supervision and management information, and a monitoring and evaluation system.

4.24 The NWMP is presently confined to Karnataka, Tamil Nadu and Andhra Pradesh, but preparations are underway to include additional states: Uttar Pradesh, Bihar, Madhya Pradesh and Kerala. Implementation so far has been slow and performance mixed; generally encouraging in Karnataka and Tamil Nadu, but slow in Andhra Pradesh and in the initial planning stage in most other states. The slow initial progress partly reflects the low priority traditionally given to management improvements relative to construction of infrastructure. The project has, however, raised consciousness of the fact that significant productivity improvements are possible in existing schemes at limited cost. Under the Eighth Plan, a large centrally sponsored irrigation management program, to be known as the "Assured Irrigation Scheme," is being considered. NWMP would eventually involve 0.6 million ha, compared with 10 million ha targeted under the Assured Irrigation Scheme. Such initiatives merit priority support by GOI. A major issue in

implementation is how the program is to expand rapidly in view of substantial planning, training and management needs when such skills among government staff and local and foreign consultants are in short supply.

## B. Sustainability

4.25 The enormous investment (nearly 10% of total Plan outlays since 1950) in India's irrigation infrastructure must be sustained and its ability to perform enhanced. Irrigation works must be designed, constructed, operated and maintained to ensure continued good performance over time. In the absence of a complete inventory, field observations by government observers and Bank staff conclude that in nearly all states, with the possible exception of Punjab and a minority of surface irrigation commands elsewhere, irrigation and drainage infrastructure is deficient and deteriorating. The principal reasons are poor initial design, poor quality of construction, and inadequate maintenance. If this situation persists, irrigation infrastructure will continue to decline, resulting in reduced ability to perform and either a reduction in surface irrigated area or a prohibitively expensive rehabilitation program. Already, rehabilitation needs are considerable.

4.26 Sustainability also has environmental, financial and institutional dimensions. Environmental deterioration is occurring on a number of commands due to lack of drainage to counteract waterlogging and salinization; other adverse environmental impacts are also occurring. Activities such as maintenance must be affordable, implying efficient use of funds, adequate generation of revenues from irrigation and the maximum handling of simple maintenance activities by beneficiaries. Institutional adaptation is also required to provide functionally specialized divisions focussed on design, construction and maintenance, and capabilities in environmental assessment. Additionally, farmers and local communities need to be incorporated into decision-making and management so that their influence is contributory rather than passive (lack of participation in operations and maintenance) or disruptive (illicit taking of water and breakages of structures).

### Design

4.27 Most design problems stem from inadequate data and unrealistic assumptions about water availability and irrigation efficiency. More complete basic data on hydrology, rainfall, soil characteristics and cropping patterns are needed. Then, agricultural objectives can be more carefully considered: the water needs for existing cropping patterns and likely future diversification; complementarity among rainfall, surface water and groundwater; and planning for conjunctive groundwater usage. Drainage must also be built into the project design, even where investment in drainage is deferred. Finally, socioeconomic conditions must be analyzed in consultation with the local community and features responsive to local circumstances incorporated (farm size and fragmentation, tenancy systems, literacy and poverty levels, social structures and the needs of women and minorities).

4.28 More realism concerning the availability of water and feasible efficiency of water usage is in order. Concern about ensuring an adequate benefit/cost ratio, exacerbated by political concerns to maximize planned irrigated areas, adds pressures to overextend proposed command areas and use unrealistic design assumptions. Irrigation efficiency<sup>48</sup> in India has often been assumed at 60%, whereas a worldwide sample of irrigation commands indicates 37-40% efficiency in regions of low rainfall (below 1000 mm) under reasonably good management, and in higher rainfall zones, an average of 23% (Bos and Wolters, 1989). Most irrigation commands in India probably have an

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<sup>48</sup> The percentage of water actually used in a beneficial way for crop growth relative to water delivered at the scheme intake. Normal losses from seepage, evaporation, evapotranspiration and spillage occur in every irrigation system, but are increased where a scheme is poorly designed, maintained and operated and by poor field application.

irrigation efficiency of 20-35%. If assumed efficiency is 60% and actual efficiency is 30%, actual water availability will be half the assumption at design. Another common deficiency is that potential irrigable area is often based on a standard 75% probability level for water availability. This has no necessary relationship with what is optimal for the command (only simulation analysis can determine this) and also often results in overestimation of potentially irrigable area.

4.29 The above practices substantially explain why many surface irrigation schemes cannot perform as hoped for. Design deficiencies are also partly behind the "gap" noted in some government commentaries between assumed created irrigation potential and actual irrigated area. Many schemes cannot deliver water in the amount as planned, and for these situations the command area targeted for coverage should be reduced to cater to these realities.

### Construction Quality

4.30 Construction quality varies widely. While there are some examples of good quality construction (Upper Ganga, Bhakra-Nagal, Beas Dam and Beas-Satluj link projects, and currently the Sardar Sarovar project<sup>49</sup>), inferior work is more common. Construction quality has deteriorated sharply, as evidenced by recent field inspections and by the frequent observation that works most in need of renovation or reconstruction were constructed in the past two decades. Poor construction is particularly prevalent with routine works such as minor, branch and major canals, including control structures and (where present) linings. Construction quality is also deficient for a number of dams, posing serious potential risk to downstream populations unless rectified. (GOI and state initiatives to address this problem will be assisted under the Dam Safety Project<sup>50</sup>.) In some cases, renovation of deteriorating works is required before projects are commissioned. By contrast, infrastructure constructed 30-100 years ago is often still sound, even when abutting deteriorating modern day features.

4.31 Attaining acceptable construction quality involves little additional expenditure. If the original design is good, it is not a question of additional materials but of a quality control process to ensure construction according to the specifications. Not achieving good quality of construction is, by contrast, highly expensive. Failure requires rehabilitation or reconstruction and for dams, presents obvious risks. Tackling the problem will require more rigorous management procedures and site supervision and increased staff training in some functions. This is certainly within the capabilities of the Indian irrigation engineering cadre, as evidenced in most states by examples of technically complex dams, canals and control structures built to good standard.

4.32 Financial factors and local pressure to take shortcuts or ignore poor quality work are the overriding negative influences on construction. During construction, large illicit profits can be made by using substandard materials, skimping on the thickness of linings, and labor-saving

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<sup>49</sup> The successful transition in the Sardar Sarovar Project (Cr. 1552/Ln. 2497), from initially problematic quality control to good quality construction now, is illustrative of the measures that need to be taken to improve construction quality. These measures included careful selection of staff and consultants to provide full competence in all required specialties, strict monitoring of the quality of cement, insistence on use of proper equipment by contractors, rigorous on-site testing and inspection, enforcement of contractor adherence to specifications in the contract, and dismissal of poorly performing contractors. Critical to success was strong back-up to on-site staff by the Gujarat state irrigation hierarchy and the political authorities. Professionalism was both insisted upon and rewarded and, in particular, quality control measures were taken seriously by state authorities, enabling staff and contractors to emphasize and implement quality works.

<sup>50</sup> The project will assist participating states and the Central Water Commission to improve institutional capabilities to inspect and evaluate existing dams on a regular basis, upgrade the safety of distressed dams identified under the program, and expand the national flood forecasting network. Four states will initially participate (Madhya Pradesh, Rajasthan, Tamil Nadu and Orissa). Other states may join in a follow-up operation.

shortcuts in curing cement. Technical and procedural improvements in irrigation departments will have only limited impact on construction quality if such corruptive influences on staff are not tackled. Creating better awareness at the state level of the consequences of these pressures is a necessary first step. Firm political will to do something will be necessary, accompanied by top-down leadership from the irrigation department hierarchy, with strong political backing and support from senior authorities. With this support, technical improvements by irrigation departments in construction design, contracting and (most importantly) in quality control during construction can substantially improve construction quality (Price, Malhotra and Fauss, 1990<sup>51</sup>).

### Actions to Improve Construction Quality

- (a) Apply rigorous quality control, during all phases of construction, with meaningful site inspections on at least a daily basis. Authority and accountability of construction supervisors must be clearly designated and an "OK" card system used for all key actions and materials used. As necessary, equipment and laboratory facilities for quality testing and additional staff training should be provided. Site supervisors should be provided with supportive advisory visits and inspections by more senior staff, and rewards and sanctions applied against staff performance.
- (b) Improve construction design. More complete compilation and analysis of basic data; care in the evaluation of site conditions and practical designs responsive to local conditions; clarity and completeness of plans and specifications; and the packaging of contracts to facilitate high-quality work are all required.
- (c) Tighten contracting procedures. Bid packaging and selection practices should include the criteria of technical competence and financial soundness (small firms often do not have the equipment and resources to do good work). Poor-quality should be subject to immediate suspension of payment and rectification; and
- (d) Increase public involvement and accountability. An independent process to audit quality should be introduced, involving consultants or an independent agency. Local communities and farmers should also be involved at each site. For the bulk of construction, local communities, which have direct interest, can assist ID supervisors by monitoring and applying community pressure on quality adherence by contractors.

### Maintenance

4.33 Signs of poor maintenance -- silt deposition, weed infestation, broken linings, malfunctioning and damaged structures -- are visible in most surface schemes, and many drains are no longer discernible. Pumping equipment in many state tubewells is also out of operation. Poor maintenance makes it impossible for irrigation and drainage infrastructure to control flows and deliver and dispose of scheduled water supplies, and results ultimately in reduction of irrigated area or in the costly need for rehabilitation.

4.34 Central Government and some states have expressed long-standing concern about irrigation maintenance.<sup>52</sup> Yet these concerns have rarely been translated into effective planning, budgeting and action in the field. Tackling maintenance requires confrontation with politically difficult

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<sup>51</sup> "Improving Construction Quality of India Irrigation Civil Works," Price, Malhotra and Fauss (Irrigation Sector Review Background Paper, 1990).

<sup>52</sup> "Maintenance of existing irrigation schemes is not getting the attention of states as required" (Public Accounts Committee, 1983); and "One of the main reasons for underutilization of irrigation potential was that the maintenance of irrigation and drainage systems was neglected" (GOI, 1990).

realities and executing unpopular actions, including halting unnecessary staff growth and addressing corrupt contracting practices. The latter is difficult to control as actions are dispersed across each state's irrigation and drainage network. Also, the results of poor or no maintenance are not readily visible in the short term. For politicians, the short-term benefits of maintenance are less tangible than the politically more attractive option of new construction. As a result, improving maintenance has remained a low priority for state governments.

**4.35 Farmer Participation.** Farmers are usually treated as passive recipients of irrigation and have not been adequately consulted in design, construction, operations, and maintenance. Consultation with local communities has improved in many states, with positive results, but much more can be done. Farmer participation is not a substitute for quality design and operation of irrigation schemes. It can, however, substantially improve the quality and acceptability of irrigation systems, as infrastructure and water management stand a better chance of being tailored to community and agricultural needs. Operational plans need to be fully discussed, understood and agreed on by farmers on an annual basis, and especially whenever significant changes need to be made. Farmer involvement creates an important sense of community participation, responsibility and ownership. Illicit taking of water and breakages by farmers or sub-groups are less likely where the community as a whole is involved in decisions and system management and implementation.

**4.36 Maintenance of Micronetworks.** Good maintenance of micronetworks (watercourses, field channels and field drains) is also important. The vastness of such networks imposes financial, staffing and administrative constraints on the irrigation departments' capacity. Although commonly recognized, in some states, government maintenance operations are increasingly being done on micronetworks. This is not financially and administratively tenable over a large area or over the long term. Instead, efforts should be made to encourage and assist farmers to do the maintenance themselves.

**4.37** Maintenance of micronetworks by farmers essentially requires a functioning and well managed main system to the government outlet so that farmers get a good irrigation service; only then will it be worthwhile for them to maintain the system at their level. Secondly, farmers must be encouraged to own their micronetworks: construction by farmers or at least a labor and financial contribution to construction. Thirdly, farmers need a grass-roots institution such as a water-user association (WUA) to organize mutual self-help in handling construction and O&M. From government, farmers need technical assistance and training in construction and maintenance techniques and help in formation of WUAs. Provision of credit (and perhaps matching grants) for investments or improvements would also be needed.

#### Actions to Improve Maintenance

**4.38** As with construction, maintenance will only be improved if the political will is there to tackle the problem and provide irrigation departments with the backing and financial support required. State and central governments must also get more involved in monitoring maintenance performance by IDs. Technical aspects are well understood; the missing elements are inadequate prioritization and loose planning, budgeting, supervision and monitoring.

- (a) Make maintenance first priority, including attention to management, staffing and budgeting (first call on state irrigation expenditure, Chapter III);
- (b) Tighten IDs' planning, budgeting and performance monitoring (using the proposed annual maintenance plan, budget and performance review, to be monitored by state and central governments, Chapter III);
- (c) Establish or strengthen a special maintenance division in each ID. Allocate high-quality

managerial and technical staff to this division, including financial analysis and monitoring capabilities; and

- (d) Support micronetwork maintenance by farmers. Extension and credit support is required. A decision is required, followed by staff reallocation, on which agency (irrigation or agriculture departments or CADAs) will provide the extension support (Chapter V).

### Environmental Issues and Trends

4.39 The environmental and resettlement impacts of irrigation are widely debated, but due to political perspectives, and lack of data, discussion has often been polarized. A balanced yet more operationally responsive approach to environmental and resettlement needs is required.<sup>53</sup>

4.40 Irrigation's Impact. Irrigation has probably had a net positive impact on the environment, largely because of its role in increasing production of food and biomass (fodder and fuel) for a growing population, thus reducing pressures on rainfed agricultural and forested land. Erosion on marginal soils, overgrazing and deforestation would have been far more acute without irrigation. Other positive impacts include socioeconomic, nutrition and health benefits from higher incomes, better and more secure food production, and village water supply. Substantial hydroelectric power is also a product of many storage-based irrigation schemes, reducing reliance on environmentally inferior thermal power stations.

4.41 Yet there are negative aspects of irrigation development, among the most evident being waterlogging and salinization where drainage is inadequate or water distribution poor, population displacement and loss of land (including forest) for canal and drainage infrastructure or inundation for reservoirs, and water-borne disease risks. Other deleterious impacts may also occur (Blinkhorn and Rees, 1990).

4.42 Waterlogging and Salinization. Situations where irrigation has caused groundwater build-up and induced waterlogging and salinization are now found on 3% of existing command area (Smedema, 1990) due to inadequate drainage. The situation is particularly serious in parts of the northwest,<sup>54</sup> and some localities can no longer be cultivated. Lack of drainage is also responsible for uncultivable saline and sodic soils ("usar lands") in Uttar Pradesh.<sup>55</sup> Installation of drainage, neglected in the past, is key to solving these problems. Waterlogging can also be reduced through improved water distribution from the irrigation system and conjunctive use of groundwater.

4.43 Land Losses and Population Displacement. Lands lost to canal and drainage infrastructure under run-of-the-river type surface schemes typically represent 2-5% of the irrigated command area created. With schemes involving reservoirs, a further 3-8% of land is lost. The area submerged depends on the dam site and the size of the project, with better topography and larger reservoirs

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<sup>53</sup> More detailed discussion of environmental and resettlement issues is in Vol. II, Chapter VI, and in the following Irrigation Sector Review Background Papers: "Environmental Issues Related to the Irrigation Sector," T. Blinkhorn and C. Rees (1990); "Land Drainage and Reclamation," L.K. Smedema (1990); and "Land Acquisition, Resettlement and Rehabilitation," W. Partridge and A. Salam (1990).

<sup>54</sup> In parts of Punjab and Haryana and localities in Rajasthan and Gujarat, water tables have risen by 25-30 cms/year since the late 19th Century in some areas (Vol. II, Figure 6.1). No deleterious yield impact generally occurs until the water table is near the surface, a problem that must now be faced in some areas through investment in drainage (Volume II, paras 6.5 to 6.11).

<sup>55</sup> Where present, irrigation will have exacerbated development of usar lands, but lack of drainage is the principal cause in Uttar Pradesh.

tending to involve smaller ratios of loss to irrigation potential created. For medium projects, submergence ratios are usually greater than 6%. By contrast, the very large reservoir being created under the Sardar Sarovar project, which has ideal topography as the dam site blocks a deep valley, will involve land inundation of only 2% of created command area. The extreme is found with some small tank irrigation schemes in southern India where a unit of land may be submerged for each unit irrigated. For India as a whole, an average of six families is displaced per 100 families provided with surface irrigation, and the livelihoods of displaced populations must be protected.<sup>56</sup>

**4.44 Forest Loss.** The Forest Conservation Act of 1980 prohibits conversion of designated forest land<sup>57</sup> to non-forest use, which frequently results in blockage of storage-based irrigation projects and complicates resettlement efforts. Expansion of irrigation and other uses of water will inevitably require submergence of land for reservoirs, in many cases, designated forest lands, thus running counter to forest policy. Deforestation concerns are legitimate and their extent underappreciated. India's remaining forest resources are rapidly being depleted by tree felling for local household needs, overgrazing, inadequate control of commercial timber interests, and agricultural encroachment by poor farmers.<sup>58</sup> According to government estimates, up to 1.5 million ha of forest are lost annually. However, total land of all types, including forest, lost annually to reservoir inundation is estimated at less than 50,000 ha (less than 4% of annual deforestation).

**4.45 Water-Borne Diseases.** Water-borne diseases, such as malaria, schistosomiasis, typhoid, diarrhea and filariasis are presumed to be a risk of irrigation, although limited information on impact is available.<sup>59</sup> Studies of the few areas in India affected by schistosomiasis show that the disease is not spreading, but the situation must continue to be monitored. Data on other diseases are diffuse and often inconclusive, though knowledge of vector life-cycles indicates that risks are present. More monitoring and research of such risks and appropriate precautions against them are needed. Risks can be substantially reduced by removing sources of stagnant or slow-moving water, frequently controllable by proper maintenance of drains and canals and efficient water management.

**4.46 Other Environmental Impacts.** Among other environmental problems cited, each meriting closer monitoring, are: chemical pollutants, such as nitrates from fertilizer, pesticides and industrial waste carried by water; river flows affected by irrigation (in particular, the situation in the Ganges basin needs monitoring); loss or change of flora and fauna habitat; and higher-than-estimated siltation of reservoirs and canals. While the last item is caused by upstream soil erosion, not irrigation, future sustainability of both rainfed and irrigated agriculture will depend, in part, on soil and water conservation practices on rainfed lands, pastures, and forest cover.

### Tackling Environmental and Resettlement Issues

**4.47 Innovative steps concerning environmental policy and successful piloting for resettlement**

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<sup>56</sup> Based on analysis of the impact on population resettlement needs of 11 World Bank-assisted projects financed between 1978 and 1988 (Volume II, Table 6.2).

<sup>57</sup> Lands classified as forests. Depletion of tree cover has, however, resulted in deforestation of much of the designated forest land.

<sup>58</sup> Discussions of deforestation and ecological degradation issues in India are contained in the following World Bank reports: Wasteland Development Review (1988), Review of Rainfed Agriculture and Watershed Development (1988), and Agricultural Review (1989). A Review of the Forestry Sector is planned in 1991.

<sup>59</sup> Positive health impacts of irrigation have also been commented on; diets are improved, water is made available for washing and hygiene, and groundwater is replenished enabling extraction for safe drinking.

and rehabilitation of displaced communities have contributed to significant, though piecemeal, progress by some states. For both issues, a national policy and ratification by individual states are required to ensure consistency of approach and widespread application. Resettlement and rehabilitation policy also needs a national legal framework. Environmental impacts have no necessary linkages to state boundaries, and such broad considerations cannot be tackled on a project or even specific-state basis. River basin planning and implementation, including environmental concerns, will be an important basis for environmentally sensitive and sustainable irrigation. Recommended actions below, while facilitated by national policies, do not need to wait for national policies to be sanctioned.

**4.48 Environmental Policy.** Since 1985, the Department of Environment of the Ministry of Environment and Forests has mandated an environmental impact assessment for all irrigation projects presented for GOI financial assistance.<sup>60</sup> While greater environmental awareness, skills and knowledge are achieved in the process, several drawbacks need attention: First, overuse of the environmental clearance to block projects with potential negative impacts has inadvertently led to circumvention by political pressures and approval of environmentally inappropriate projects. Earlier assessment of environmental impact, with a view to incorporating design features to minimize environmental damage, would be a better approach. If satisfactory solutions cannot be found, project blockage may still be appropriate, but this decision needs more measured consideration of full project costs and benefits, including the environment, rather than the single yardstick of environmental impact. Despite environmental assessment, project implementation has often fallen short of adequate handling of environmental concerns and objectives. Follow-up environmental monitoring and remedial actions are also required. Finally, the environmental assessment procedure, while useful for project-level decisions and implementation, is too limited, and requires a broader context. Environmental understanding is beset by a lack of data and insufficient skills in measurement and analysis. The institutional apparatus for handling environmental analysis, making decisions, and funding and implementing environmental research is still limited, and river basin planning has hardly been attempted.

**4.49 Actions to improve environmental assessment and impact.**

- (a) Prepare a national policy for environmental management in irrigation to be done jointly by MOWR and Ministry of Environment in coordination with state governments. State governments should subsequently ratify this.
- (b) Address specific environmental concerns through project investment. The largest future need will be for drainage investment, already a large component in several World Bank-financed projects (e.g., Second Punjab Irrigation and Drainage Project, Cr 3144/Ln 2076), and Narmada Water Delivery and Drainage Project Cr 1553). Specific measures dependent on project location, type and local environmental issues will also be required (for instance, the Upper Krishna Phase II Project, Cr 2010/Ln 3050, includes pilot actions to control against malaria). For all projects, any necessary project related environmental monitoring or applied research should be included.
- (c) Conduct environmental impact assessment as early as possible in project identification and preparation, make it integral to this process, and use it to influence project selection and design;
- (d) Expand environmental monitoring and applied research by the states, supplemented by nationally implemented work. Increasingly, monitoring should be handled on a river-basin level. Central guidance could be provided by MOWR and its implementation agencies in coordination with the Ministry of Environment;

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<sup>60</sup> The World Bank also has an Environmental Assessment procedure conducted during project preparation.

- (e) Improve institutional capabilities to address environmental concerns. At the state level in particular, such capability is still rudimentary. Adaptation and strengthening of existing institutions would be preferable to creating new ones. Staff need to be trained, institutional roles and interrelationships defined, and financial resources provided for data collection, analysis, research and monitoring; and
- (f) Recognize and use pricing mechanisms for environmental management. Pricing of electricity for wells is a serious issue. Market signals to private users offer the only mechanism that can be expected to curb overexploitation, a problem that has already had deleterious effects on the water table in numerous areas.<sup>61</sup> Although administratively difficult, meter-based full pricing of power would have positive environmental, as well as fiscal, impact;

4.50 Policy on Land Loss. The issue of land loss and its impact on productivity, the environment and local populations, while important in assessing irrigation proposals, should be recast in the broader context of optimal land use and the costs and benefits associated with alternative land uses. The direct and indirect costs of land (and forest) losses have to be factored into the rate of return calculations used in assessing project proposals. Costs and benefits may vary considerably, depending upon type of project, the ratio of lands lost to lands brought under irrigation, population density, the expected productivity of irrigation investment, and the economic, ecological and social value of the lands that would be lost. The question is more complex if value is difficult to quantify, as in the case of the ecological value of well forested lands, lands holding endangered flora and fauna, or lands of historical or spiritual significance. However, all such assessments should be made on as full an analytical base as possible, taking into account both costs and benefits, including full presentation to decision-makers and the general public of non-quantifiable factors.

4.51 Forestry Policy. Several modifications to forestry policy are recommended. First, closer examination of tree cover in designated forest land is needed. Much designated forest has been substantially degraded and this should influence the evaluation of ecological impact or potential reservoir site. Second, afforestation as an associated investment with irrigation development should be considered. Under the Sardar Sarovar project, for instance, for every hectare inundated, two hectares of land will be reforested.

4.52 Resettlement and Rehabilitation (R&R) Policy. Resettlement and rehabilitation of communities displaced by irrigation has rarely been satisfactory. For those displaced due to development of canals, drains and inundation for reservoirs, alternative government land has often not been available. While cash compensation has usually been provided to land owners, it has generally been inadequate to purchase new land. Further, tenant farmers and landless families often receive no compensation, and physical infrastructure and services for rehabilitation have rarely been provided. This situation is unacceptable. It has also compromised the general public's trust and is a major factor behind much of the controversy over current irrigation development. Unless this issue is resolved, it will only worsen due to population pressure. The fact remains that the creation of water storage is critical to future development of water resources in most regions. However, the welfare of all displaced persons must be protected, and ideally they should become net beneficiaries of irrigation development.

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<sup>61</sup> Western Uttar Pradesh offers an example of declining groundwater tables (by 30 to 50 cms per annum in some areas). Some scope for controlling overexploitation of groundwater is available from administrative measures. As at present, credit for investments in wells can be restricted in areas where groundwater tables are declining. But this will not affect investments without credit unless such investments can be prohibited. Such policies are likely to be only partially effective, especially over the long run.

4.53 The need for change is now generally recognized. At field level, some advances have been made, notably in Gujarat under the Sardar Sarovar project. Features include: designation of a minimum land holding for resettlement (2 ha of irrigated land per resettled family member, including landless families); adequate funds for purchase of land; assistance in R&R through Land Purchase Committees; and active support from government staff and NGOs. Public infrastructure (roads, electrification, drinking water, schools, etc.) is also being created. Detailed planning and establishment of institutional capabilities have provided the necessary backing for these efforts. While initially slow and requiring adjustments, implementation in Gujarat provides valuable lessons for replication elsewhere.<sup>62</sup>

4.54 Encouraging examples are few, and R&R still lacks an underpinning policy and legal framework. Overall, funding is limited, planning rudimentary and institutional arrangements for implementing R&R need to be developed. Nevertheless, welcome initiatives are being taken. In 1989, a Draft National Policy on Development Resettlement was prepared jointly by NGOs and the GOI Commissioner for Scheduled Castes and Scheduled Tribes, followed by a draft proposal on revised national R&R policy which GOI recently discussed with the Bank. The National Water Board has established a sub-committee on R&R. Several states (Maharashtra, Karnataka and Madhya Pradesh) have passed legislation defining policies for resettlement or have commenced deliberations on future R&R policy (Orissa and Bihar). Such initiatives, and practical experience gained under Sardar Sarovar, provide a basis for a more comprehensive approach to R&R and its effective implementation in the field, as discussed below.

#### 4.55 Actions to Improve Resettlement and Rehabilitation.

The basic principle of R&R should be to enable those displaced to improve or at least regain the standard of living they had prior to displacement, through restoration of their productive capacity. The objective should be to make displaced persons net beneficiaries of an irrigation development project, and their welfare should be catered for accordingly (Partridge and Salam, 1990<sup>63</sup>). The key actions are<sup>64</sup>:

- (a) Provide land with similar income-generating capacity to that lost. This is the key need, and involves either prior agreement with beneficiary communities on giving up part of their lands in return for the new irrigation service, or provision of government funds for purchase of land from other farmers. The former may be more appropriate in areas of high population densities such as eastern India. The latter is being used in Gujarat.
- (b) Adopt a whole community approach. R&R must have a whole community approach and also cater to the needs of landless, minorities and women.
- (c) Provide supporting services. A package of supporting services (roads, village water supply, electrification, schools, clinics, training, and other infrastructure and services) is needed to allow newly resettled communities to reestablish themselves.
- (d) Establish a Land Acquisition, Resettlement and Rehabilitation Plan, in discussion with the affected communities. Implementation of R&R at the project level is a complex process requiring substantial hands-on involvement of local authorities, community

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<sup>62</sup> R&R under the same project in neighboring Madhya Pradesh has also improved recently, though progress still lags behind the Gujarat program.

<sup>63</sup> "Land Acquisition, Resettlement and Rehabilitation", W. Partridge and A. Salam, (Irrigation Sector Review Background Paper, 1990). Also, see "Involuntary Resettlement", World Bank Technical Paper No. 80.

<sup>64</sup> More detailed recommendations are in Volume II, Chapter VI.

leaders and NGOs. This should have detailed agreed actions, organizational procedures, institutional and staffing requirements and costs.

- (e) Finance R&R fully as a project component. R&R must be financed not as a supplement but as an integral part of irrigation development and the full funding provided to this project component; and
- (f) Prepare a National R&R Policy Paper. The above measures can be implemented now on a project-specific basis, but will be facilitated with a clear policy and legal framework. The R&R Policy should be prepared in consultation with state governments. This should be followed by revision of the Land Acquisition Act and the passing of any necessary similar legislation at state levels.

4.56 With experience, further improvement of R&R implementation will be possible. To this effect, studies and monitoring of R&R programs are needed. Creation of exactly comparable sources of livelihood is frequently not feasible, and particular problems emerge in accommodating groups such as tribal peoples where sources of livelihood are diffuse and not perfectly matched by provision of agricultural land. Nevertheless, while some imperfections are inevitable, under a well-designed and implemented R&R program material welfare of those displaced can be protected and even enhanced, and this needs to be a standard feature of irrigation development.

## CHAPTER V. GOVERNMENT/PRIVATE ROLES AND CAPACITY

5.1 Largely as a result of the agricultural sophistication that irrigation has helped induce, management of the irrigation sector has become increasingly complex. Taking yields beyond their present level now requires more exacting water management and a broader range of technical, financial, planning and managerial skills. Not least, the vast scale of operations, maintenance, financing, and general management poses increasing challenges. Yet, irrigation management remains exclusively handled by a governmental structure that has changed little over many decades, and institutional capabilities have declined as a result of limited adaptation and increasing encroachment of political and rent-seeking pressures on sector managers.

5.2 Improving the performance of irrigation will depend most fundamentally on clarifying who does what most effectively, government or the private sector; reforming institutional roles as necessary; and enhancing the incentives for and capacity of both government and private sectors to perform. For the government sector, there is a major need to reform management to achieve greater autonomy, accountability and transparency of decision-making and performance. A long-term vision should come into focus, with practical steps implemented for the short- and medium-term in getting there.

### A. Situation and Trends

#### Dominant Public Sector

5.3 Indian irrigation is dominated by the public sector whose role has increased over time. The scale of most surface schemes in India has necessitated government funding, and similarly, operations and maintenance of these schemes require some public sector involvement. Government management usually extends to the outlet from the minor to the chak (i.e., in most instances, parcels of about 40 ha) and has entailed a large network of grassroots irrigation officials. Collection of water charges also involves a substantial government apparatus. Similarly, with the construction and maintenance of micronetworks, government is becoming a major player. In southern India, management and maintenance of tank irrigation schemes formerly constructed and managed by local communities have increasingly been assumed by the public sector. A notable exception to this trend is the rapid growth of irrigation through shallow tubewells and dugwells where government has played a supporting rather than implementation role, restricting activities to provision of credit, monitoring of groundwater levels and selective investment subsidies to poorer farmers. Nevertheless, even here, where private investment is demonstrably successful, substantial government efforts in eastern India have gone toward development of public tubewells.

5.4 Many functions do need to be handled, or at least steered, by government: policy formulation, planning, design and supervision of public works, legislative and regulatory functions, and some monitoring and support services such as extension and research. Yet, continued reliance on government for sector implementation carries a high fiscal cost, putting the government budget under heavy strain, and diminishes effectiveness in face of the increasingly difficult task of managing infrastructure which is vast in scale and government units that are inadequately structured and trained to meet changing conditions.

5.5 India relies much less on farmer and local community initiatives, autonomous bodies for scheme management and involvement of private entrepreneurs, consultants, and other non-governmental organizations than many other countries, where they have proven to be a source of vitality and support. Their collective resources should be tapped, and this overview of sectoral performance points to action beyond improvements of existing government institutions to invigorate the sector. Central administrative structures should, as far as possible, be divested to more autonomous local bodies accountable to irrigation's users and with user participation in

management.<sup>65</sup> All practical possibilities for divesting government investment or implementation to the non-government sector should be pursued. As discussed below, large opportunities are available for divesting at least part of irrigation implementation and management to farmers, entrepreneurs, consultants, NGOs and other government or semi-government bodies. Opportunities are also available for encouragement of investment by farmers and entrepreneurs; for instance, in groundwater investment and development of micronetworks.

### State Irrigation Departments (IDs)

**5.6 Implementing Agency.** India's entire surface irrigation and drainage network is primarily managed by state irrigation departments (IDs). IDs handle the planning and design of irrigation and drainage works, supervise contractors during construction, and are responsible for operation and maintenance of completed schemes, as well as monitoring and financial management. The capability of each ID is the principal determinant of success or shortfall in the state's irrigation sector. Although some states manage to do a largely exemplary job (e.g., Punjab and Haryana), performance of most IDs is weak. The management task is formidable, given present structures and capacity. Many IDs manage an aggregate irrigated area that is larger than that of most countries (Vol. II, Annex Table 7.2). Decentralization and actions to improve management can help, but bureaucratic constraints and inherent disincentives are less easily tackled.

**5.7 Incentives.** IDs and government command-level structures such as CADAs suffer from weak incentives to perform. Political pressures are a large part of the problem. They influence decision-making favoring new constructions. Creating unproductive jobs for constituents is tolerated, even encouraged. Staff rewards and senior staff appointments are often biased in the direction of compliance with such expediencies. Yet more damaging is the growth of corruptive influences. Salaries are modest and salary levels and promotions are minimally affected by performance. By contrast, large financial gains are possible through collusion with contractors or illicit collection of revenues from farmers in exchange for water distribution favors. Such practices have become increasingly common and critically alter incentives; they discourage efforts to improve quality control of both construction and maintenance, to make water management more equitable and to improve cost recovery. Good monitoring and sound financial management also carry little reward as they serve to expose these deficiencies.

**5.8 Accountability.** These pressures are compounded by a marked lack of accountability. While ID budgets are approved by state finance departments, and central government approves investments involving central Plan funds, in most states these have proven to have little influence on performance levels and even on the use of funds. Such monitoring is restricted to desk auditing of accounts. There is minimal outside monitoring of field performance by state governments, little requirement for publicly available reporting, and as farmer participation is minimal, little effective means for users to put pressure on IDs to improve performance. A fundamental need is to increase the accountability and transparency of decision-making in the sector, to other government institutions, to the general public and, in particular, to the users of irrigation.

**5.9 Structure and management.** Several managerial problems in IDs relate to their organizational structures, staffing and training, mainly responsive to construction engineering needs (Frederiksen, 1990<sup>66</sup>). Most IDs are organized on the basis of geography, managed downward through successive supervisors to "circles," each managed by an engineer having responsibility for all irrigation activities within the area. A large number of entities reports to the

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<sup>65</sup> "Need for a Strengthened Private Sector in Irrigation: The Service Industry and the Users." H. Frederiksen (Irrigation Sector Review Background Paper, 1990).

<sup>66</sup> "Staff Capability - Personnel Policies, Specialization and Training," H. Frederiksen, (Irrigation Sector Review Background Paper, 1990).

state Engineer in Chief and Secretary of Irrigation at the top of this pyramidal structure.<sup>67</sup>

5.10 Meanwhile, irrigation development and management have become more complex. Site conditions are usually more difficult, more demanding design and construction techniques and materials are used, planning must encompass increasing water scarcity, and the demands of multiple use require more thorough and holistic analysis for a whole river basin. Progressively, the operations and maintenance function has become more important as the stock of irrigation infrastructure has grown. In most states, especially those where water development is nearly complete, it is now the dominant functional need for irrigation management.

5.11 Changing needs are taxing staff capabilities, limited almost exclusively to general engineering. More skills in specialist aspects of construction are required, and staff with expertise in water resource planning, hydraulics, water management, irrigation techniques, and maintenance are particularly scarce. As important, non-engineering skills need incorporating: business planning and management; cost accounting and financial analysis; monitoring and economic analysis; and socioeconomic and environmental considerations.

5.12 Staff training. Opportunities for career specialization, on-the-job training, and cross-fertilization across states and with other countries are limited. There is no induction training for engineers entering the irrigation service and scant skill development or refresher training is offered during an engineer's career. Exposure to ideas outside the state or to irrigation management techniques and research in other countries is rare. These problems are exacerbated by the practice of transferring staff to different jobs in the ID at frequent intervals, resulting in lack of career development in any one field and also in disruptions of work programs. In most states, while exceptional individuals exist, the average professional quality of irrigation engineers has probably declined over time, and there is a marked absence of the non-engineering skills discussed above.

5.13 Since the late-1970s, Water and Land Management Institutes (WALMIs) have been set up in 10 states to provide general training to ID engineers in water agronomy and management and some engineering to agriculture department (AD) staff involved in irrigation. The need for WALMIs remains evident, but their effectiveness is hindered by a lack of focus on training needs and a too-theoretical approach to what are essentially practical technical problems.

### Coordination

5.14 In most states, there is a need to define better the roles of different institutions involved with irrigation and to ensure that functions sometimes falling between them are effectively carried out. Construction and general agricultural extension are clearly defined as functions of the irrigation and agriculture departments, respectively, but other functions are either not assigned or, more commonly, are assigned without staff expertise and resources to handle them nor incentives to perform the tasks well (see below). Even where roles are clear, coordination among government departments is often weak.

5.15 Extension. Important extension functions are deficient. Water agronomy is neglected, because agricultural extension staff lack training in the optimal use and timing of water. Farmer knowledge is notably weak in this area and is partly responsible for a tendency for head-reach farmers to overwater their crops. Support for farmer participation in irrigation is also weak. Little extension advice is provided to farmers on how to form water-user associations and the benefits thereof, as this objective is seldom defined as a priority for one or other of the government agencies. Finally, limited contact among irrigation departments, farmers and agriculture departments has often reduced the effectiveness of surface irrigation design and subsequent

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<sup>67</sup> ID organizational restructuring to create functional specialization is underway in Punjab, for description refer to Second Punjab Irrigation and Drainage Project Appraisal Report (Cr. 2076/Ln. 3144).

operations in meeting agricultural needs. Scope usually exists for improved timing of water delivery, based on regular in-season meetings involving farmers and agriculture officials.

5.16 Major shortfalls occur in the construction and maintenance of micronetworks (watercourses, field channels and field drains) and the efficiency and equity of water distribution at that level. Irrigated area, productivity and equity are thus substantially reduced. Government efforts have primarily emphasized government-executed construction of micronetworks, either by the ID, engineering wings of AD, or by the Command Area Development Authorities (CADAs), at the expense of farmer involvement. Resource constraints have limited the number of micronetworks constructed.<sup>68</sup> Further, farmers assume that maintenance of government-constructed works should be done by government and maintenance has been poor. Also, little advice has been provided to farmers on water management at the micronetwork level, a common deficiency except on the well-established warabandi schemes in the northwest. A larger, more sustainable and much less costly impact would have been achieved if farmers had been assigned these tasks and encouraged to feel they own and are responsible for their micronetworks. The government role should be revised to a strong extension function: topographic surveys, layout design and advice on water management and maintenance subsequent to construction. However, only a few pilot efforts have been made in this direction.

5.17 CADAs. A major government initiative aimed in part at responding to these problems was the establishment of Command Area Development Authorities (CADAs). The CADA program began in the mid-1970s, and there are now 54 CADAs covering 131 command areas representing a total command area of about 18.5 million ha. CADAs were intended to address several of the problems discussed above, notably construction of micronetworks and coordination of different government services involved with irrigation. CADA structures and functions vary widely across states. In some states, the CADA is essentially an executive committee intended to coordinate the activities of different government departments. In practice, many have not succeeded, because of conflicting instructions from line department heads. In others, staff have been seconded from different line departments to CADAs, becoming additional implementing agencies. However, with implementation responsibilities often confined to government construction of micronetworks, such CADAs have in effect become specialized construction departments. For most CADAs, the key problems remain: still-weak coordination between irrigation and agricultural services, limited (and costly) progress with construction of micronetworks, poor maintenance and water management on such micronetworks, still-weak extension for irrigated agriculture needs, and limited efforts to generate farmer involvement. A basic problem is that CADAs remain as government departments and have had difficulty in improving on the performance of other government departments that they were intended to supplement. This existence has seldom compensated for weak performance of IDs and other departments involved with irrigated agriculture. For most CADAs, unless they can be transformed to become managerially and financially autonomous scheme management entities, there is no strong case for retaining them.

### Farmer Involvement

5.18 While government policy statements support farmer involvement, little has actually been done at the field level, and much of what has been done has been promoted by NGOs. Indeed, field experiences have often been the reverse, with increased government assumption of implementation in states such as Haryana (micronetwork construction and maintenance) and in several eastern states regarding public tubewells. This contrasts with the historical development of irrigation which relied substantially on local community investment and operations. The current situation and trends need to be reversed and much can be learned from past experience. There are

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<sup>68</sup> Micronetworks for 0.5 million ha were installed in 1989, a fall-off from earlier development in the mid-1980s.

also a number of recent pilot efforts to learn from (Datye and Patil, 1988), as well as experience from cooperatives in other sectors in India and from water-user associations (WUAs) in other countries. Experience is mixed but provides sufficient guidance for implementation of government actions to promote WUAs (Bottrall and Kathpalia, 1990).<sup>69</sup>

## B. Using the Private Sector

5.19 A first and fundamental need in sectoral management is to reconsider and decide on the appropriate role of the public sector in irrigation development. The considerable initiative and dynamism of farmers, entrepreneurs, consultants, universities, research institutes, and NGOs are untapped. Further, government can no longer afford to shoulder the cost, especially at inefficient levels of expenditure, of the sector's development. Government should retain certain responsibilities (para 5.4) but increasingly it should devolve major portions of irrigation investment, operations and maintenance to the private sector, including farmer beneficiaries.

### Private Investment Opportunities

5.20 Groundwater Development. The two largest opportunities for private investment are in groundwater development and development of micronetworks for surface irrigation. Groundwater development is already primarily in private sector hands, with government playing an important supportive role. While inadequate pricing of energy remains an issue, in other respects the rapid expansion of private groundwater irrigation in the past three decades is a major success story for the Indian irrigation sector. By contrast, the public tubewells in eastern India (Uttar Pradesh, Bihar and West Bengal) have proven costly, difficult to maintain, to have generally lower yields and have involved particularly high subsidies. Future investment should be focussed exclusively on private development of wells, with government back-up in the form of groundwater monitoring, planning of surface irrigation development to facilitate conjunctive groundwater exploitation, and provision of policy and legislative guidance, research, extension and access to credit. Where deep tubewells are required and would not deleteriously affect groundwater levels and downstream surface flows, private investment in them can be encouraged. Collective ownership by small groups of farmers, perhaps using smaller capacity pumps, might be feasible. For overly large groups, social organizational problems could hinder collective ownership. Alternatives are investment by wealthier farmers or entrepreneurs and water selling, a practice that has become common even with the small shallow tubewells.

5.21 Micronetworks. Farmer participation in surface irrigation, especially to construct and maintain micronetworks, is a missed opportunity. An alternative to the public sector is required, but first the constraints limiting private investment, in part, induced by the political environment, must be tackled. Politicians have frequently encouraged an attitude among rural constituents that government assistance is a right. More specifically, little effort has been made by IDs or CADAs to establish WUAs, yet some form of community structure is essential for farmer investment in communally owned infrastructure and for subsequent successful operation and maintenance. In Pakistan, micronetwork development is a farmer responsibility with government providing technical assistance for micronetwork layout and construction. Farmers are required to establish themselves in water-user associations before they are eligible to receive credit. Such measures could work in India. Opening of a minor could be conditional on completion of WUA formation and micronetwork construction for a majority of the chaks, and opening of an outlet from a minor conditional on completion of chak infrastructure. Existing government services could be adjusted to provide a strong technical assistance input and ready access to credit. Matching grants might also be considered, though experience in other countries indicates that this is not essential.

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<sup>69</sup> "Farmer Participation in Irrigation Sector Management," A. Bottrall and G. Kathpalia, (Draft, 1990), (Irrigation Sector Review Background Paper).

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## Creating Autonomous and Accountable Institutions

**5.22 Alternative Structures.** For all surface irrigation and drainage commands, the ultimate objective should be the creation of managerially and financially autonomous entities responsible for water management and maintenance and answerable to irrigation's users. Examples in other sectors in India and of irrigation in other countries pertain. Institutional alternatives to government departments in India include registered societies, boards, public utilities, cooperatives and mixed private/public ventures. These entities have greater freedom and flexibility than government departments, and comparatively greater public accountability due to established open auditing and review procedures. In irrigation, entities such as the Bhakra-Beas Management Board, Sardar Sarovar Narmada Nigam Ltd, several WALMIs and CADAs organized as registered societies, and the Damodar Valley Corporation have demonstrated that creation of alternative structures adds flexibility and dynamism. Wherever possible, such options should be further exploited.

**5.23 International Examples.** In China, for example, irrigation investment and management responsibilities are decentralized. The starting point is river basin administration which transcends other boundaries for aggregate planning and monitoring of water resources. For a major command, a command-level authority confines its role to major structures and canals. Implementation is decentralized through contractual agreements between successive layers -- command, prefecture, counties and village groups. Each level is expected to carry out the works assigned to it, to reimburse loans received, and to ensure cost recovery from the level below. Water charges are used within the irrigation scheme for reimbursement of investment loans and funding of maintenance and administration, with agreed percentages taken by each administrative level. At the base, farmer implementation is strong. Accountability at each level and the discipline imposed by clear designation of responsibility and financial autonomy encourage frugality and efficiency.

**5.24** In Korea, the center's role in implementation is restricted to planning and monitoring of water resource development by the ministry, and construction of major schemes by the Agricultural Development Corporation. The corporation operates each scheme for two years and then hands over operation and maintenance to farmer-managed boards -- farm level implementation agencies (FLIAs) -- which employ professional managers and fund themselves through water charges. Japanese irrigation is managed by farmer cooperatives which secure funding and employ contractors for irrigation expansion. Countries such as Mexico and the Philippines are moving towards the features found in China and Korea. Under the Mayo project in Mexico, irrigation districts formerly managed by the state are being handed over to farmer organizations responsible for blocks of about 3000-5000 ha, following successful experience with this approach under earlier projects. In the Philippines, minor schemes are managed by farmers and central investment assistance for expansion or improvement is conditional on the existence of an irrigation association and farmer participation and contribution to investment. For large schemes, starting in the mid-1980s, a phased process for eventual handover to farmer management has commenced, starting with farmer participation in maintenance, revenue collection and operations, and leading to water fees retained at command level and managerial and financial autonomy. The transition is being promoted through strong government technical assistance and training.

**5.25 Modelling Success.** The common features of these successes are: a reduced role for government administration; significant participation, management and often ownership by farmers; and scheme-level autonomy, including the generation of funds. Similar arrangements are recommended for India, but implementation will need practical steps to progress from the existing situations. One opportunity is presented by CADAs. Successful CADAs could be given more independent statutes (as registered societies or boards as found in some states), allowed to retain water charges, and given a phased but finite time period for progressively reduced government financial contributions and increased farmer participation in management. The hand-over would need a strong extension effort to create WUAs, and successive tiers of farmer representation in

higher-level management, accompanied by a phased program to reduce government staffing and to place remaining staff under CADA authority employed and answerable to the farmers. Scheme infrastructure should also be repaired to good condition as part of the hand-over agreement. In states such as Kerala, CADAs are already more autonomous than elsewhere and this transition could be more rapidly implemented.

5.26 Another opportunity is presented by existing institutions or where new institutions are desirable. The Bhakra-Beas Management Board (BBMB) usefully coordinates water distribution among Punjab, Haryana and Rajasthan. In many river basins, there is also a need to create institutions for managing water planning and distribution between states and users. These should be created on a commercial basis, as far as possible, with clearly defined fees, rights and obligations for each user entity and the overall basin authority. During the planning of new schemes, the eventual institutional structure and financial arrangements should be agreed with users from the outset. Such innovations will take time to become widespread, but opportunities exist in all states to implement pilot developments.

5.27 Contractors, Consultants, Universities and NGOs. In parallel, large opportunities are available now to IDs to promote increased private sector participation. Contractors can play a much larger role in irrigation development. For maintenance, use of force account is still common. Yet under existing law each laborer or foreman hired by government tends to become a permanent annual wage and pension obligation, adding to recurrent costs. Maintenance should be completely handed over to contractors, with the scheme manager's role as a monitor and enforcer of maintenance standards, including independent outside monitoring where scheme management is still under ID administration.

5.28 To date, the use of private consultants has been limited. The irrigation-sector consulting industry is in the early stage of development, but consulting capabilities have grown over time through the efforts of retired engineers, and a large consulting capability in other disciplines already exists. GOI and IDs should more actively enhance their technical expertise by using consultants in needed areas without adding to the permanent payroll. A large part of the consulting input is needed in fields such as management information and monitoring systems, cost accounting, economic analysis and non-engineering aspects of project preparation. Foreign consultants could also be used more actively. This recourse is rarely employed in India due to foreign exchange considerations. Yet few, if any, countries are in a position to develop a complex sector without use of international consultants. For major projects it is generally essential and is proving an important input in the Narmada development program.

5.29 The resources and initiative of universities, research centers and NGOs can also be contracted more widely. A network of universities and research centers exists in all states and has in a number of cases been used effectively to support irrigation development at relatively low cost. These institutions could be used more extensively to undertake monitoring and evaluation, baseline surveys, some technical research, part of the in-service training of ID staff and assist with irrigation project preparation. Scope also exists for more active use of NGOs which have been effectively used in irrigation activities requiring a grass roots involvement such as promoting WUAs, implementing R&R programs, and catering to the needs of women and minorities.

5.30 Private-sector Labor. Also, the present large network of ID minor officials used for basic irrigation management (e.g., canal inspectors, public tubewell operators, collectors of water charges, Jilladars, Patwaris, etc.) could be eliminated. Most such functions can be better handled by village laborers employed, paid and answerable to WUAs. WUAs would decide on the level of staffing required and would have the ability to discharge personnel performing unsatisfactorily, a feature deprived to government. State back-up could be restricted to a good training and technical assistance function. If government control of implementation is still considered necessary, contracts can be established with private firms to provide staffing, enabling future flexibility to

change unsatisfactory staff or to dispense with such functions.

### C. Improving Government Institutional Performance

5.31 While the above recommendations would enable a much larger role in irrigation for the non-government sector, an important government role will remain. Even in the long term, government will need to plan water resource development and coordinate its exploitation (but increasingly through river basin authorities, to monitor sector performance and to channel government funds, including supervision of contractors, for large public works. As transition will take time, IDs will remain primarily responsible for irrigation development and management in the medium term. The following measures are recommended to improve the management capabilities of IDs and to steer government sector management functions towards its longer-term role.

#### Restructuring Irrigation Departments

5.32 Functional Specialization. The present structure of IDs, which is inadequate for functions other than construction, should be restructured to create specialized headquarters divisions, typically: operations, maintenance, planning, design, construction, training and staff development, monitoring and evaluation, and administration (Volume II, Figure 7.3). Such functions should also be reflected at the circle level. Many circles would have operations and maintenance as their only function and need to be properly trained and motivated to do this well. Parallel efforts are needed to create greater specialization within the engineering cadre. Particularly for non-construction activities, staff specialization needs to be fostered through career development opportunities, reduced transfer rates for staff and, as possible, through special financial incentives (e.g., supplementary housing or transport allowances) for less popular functions such as design and planning. As important, non-engineering skills need to be incorporated (e.g., cost accounting and financial management, monitoring and economic analysis, and socioeconomic and environmental disciplines). Training of existing staff also needs to be intensified and would be facilitated by the training and staff development division proposed below.

5.33 Staff Training. Training and access to ideas in other states and countries will form the basis for the future vitality and competence of the sector's institutions. Professional capabilities of staff should be upgraded. A training and career development division should be established in each ID to provide the necessary management focus on this objective. Using existing training facilities (field training centers and WALMIs), supplemented by contracts with universities and consultants, training targeted toward the priorities established by each ID is also needed. Other state resources include universities, engineering institutes, and various training institutions in management, finance, and economics. A well-used budget for utilizing such centers could provide greatly expanded training at reasonable cost. These initiatives should be supplemented by exchange programs and visits to irrigation projects and institutes in other countries. While the budget for such training and exchanges would be much increased from present minimal levels, it would still be small relative to other budgetary items for irrigation and should not be skimmed.

5.34 Some rethinking is recommended for the WALMI training programs. Training has tended to be too theoretical and has not had much practical impact. Training for ID staff should be adjusted to feature water management, maintenance and design, and include management skills, cost accounting, diagnostic analysis, monitoring and planning. Training in agronomy for irrigation engineers can be kept to the minimum needed for engineers to be able to relate to agriculture staff and agricultural concerns. For the staff identified to provide the technical assistance to farmers for WUA formation and construction and maintenance of micronetworks, WALMIs need to provide practical training for these needs (in community organization, basic hydraulics, topographic surveying, simple construction skills, water agronomy).

5.35 No Growth in Staff. These adjustments do not necessitate growth in overall staff numbers.

To the contrary, existing staff need to be reallocated, deserving cadres sent to short- to medium-term training courses, and consultants used for specialized activities and training. If some additional hiring is needed in non-engineering fields, it can be more than compensated by attrition due to retirement.

**5.36 Management Culture.** At the heart of such improvement measures is the need to create in each ID a "management culture" incorporating skills and perspectives of management specialists, economists, financial analysts, agriculturalists and other specialties. Above all, skill, motivations, and techniques used in successful private corporations should be emulated. No government entity has the full managerial freedom of a private enterprise, but within existing constraints, much can still be done: establishing priorities and use of staff assignments to achieve these priorities; use of management information systems for rapid diagnosis of problems; establishing accountability for staff and providing rewards related to performance; and use of cost accounting to analyze performance of all key ID activities.

**5.37 Political Will.** Success will depend primarily on orientation and support from each Secretary of Irrigation and importantly, the support he receives from the state leadership. Wherever a Secretary's decisions are reversed or undermined by political interference, there is little possibility to change matters. This has increasingly been happening, and in a major degree in some states. Staff appointments, investment decisions, selection of contractors, monitoring of construction quality and other implementation matters, and policies related to cost recovery are less and less governed by objective criteria. By contrast, where political involvement has been judiciously applied in a positive manner, this has proven an invaluable supporting force for change.

### Coordinating Government Institutions

**5.38** The respective roles of IDs, ADs, CADAs, other government institutions and farmers need clarifying in a number of states. IDs need to concentrate on ensuring that the main irrigation and drainage systems operate and are maintained well. Below the government outlet, construction maintenance and operation of micronetworks should be made a farmer responsibility. This will only be successful if credit, extension, and technical assistance services are provided to farmers to help them establish WUAs and for design of micronetworks. Either the roles of CADAs need to be adjusted to this function or special extension wings of ADs or IDs provided for this extension purpose. Agricultural extension by ADs also needs to be improved, particularly in water agronomy. Despite the existence of CADAs, coordination between government departments often remains weak; as done in some states, coordination committees at state, district and scheme level (Volume II, Figure 7.4) could help improve coordination. It is also noteworthy that the states without CADAs -- Punjab, Haryana and Tamil Nadu -- have managed in these and other respects as well or better than other states. A feature of these states is that the IDs have better management than typically found elsewhere. The workable alternative to CADAs has been to concentrate on ensuring that each department (irrigation, agriculture, etc.) fulfills its assigned role and that necessary coordination is achieved.

### Increased Role for Farmers

**5.39** Regarding public delivery of irrigation services, the goal is to assign roles clearly so that necessary irrigation and support functions are performed well, without adding to overall cost and staffing. This necessitates a greater role for farmers. The central government and several state governments endorse the view that farmer participation through water-user associations (WUAs) or other forms needs to be promoted so that farmers can participate in or assume decision-making, management and implementation of irrigation operations, especially of micronetworks. WUAs provide a local forum for decision-making and resolution of disputes between farmers by the user community as a group. They also provide a community structure for undertaking self-help, such

as maintenance, watercourse lining and better water management, based on local knowledge of how the system is working and farmers' needs. Farmers should be responsible for construction and maintenance of watercourses, field channels and field drains and management of water at chak level. They should also progressively participate in management at higher levels in the irrigation command; representatives of committees at chak level can form committees at minor level, and subsequently at the whole-system level eventually leading to the longer-term goal of farmer management of autonomous schemes.

**5.40 Participation and Benefits for Women and Minorities.** Nearly half of agricultural labor is female, and over 30% of poor households in rural India are headed by women. Similarly, a disproportionate number of poor households are landless families or minority groups such as scheduled castes and tribes. In the case of irrigation, men traditionally make decisions on water allocation and participate in monitoring of usage, and larger families from more influential societal groups have the largest say. Raising the productivity of women, the poor and minority households requires specific features in irrigation project design and implementation to cater for their greater participation (Mitra, 1990<sup>70</sup>): representation in water-user associations; extension services designed to reach these groups; and access to drinking water, irrigation for communal fodder and woodlots and water facilities for cattle, bathing and laundry.

**5.41** Initial project design should include a baseline socioeconomic survey to ascertain the needs of women and minorities. Such actions are increasingly present in projects, often with assistance from NGOs. These initiatives now need to be more systematically applied across the sector as a whole.

**5.42 Developing Water-User Associations.** Promotion, development, and support of water-user associations is likely to be the most effective vehicle, short-term and long-term, for effecting farmer participation and control of irrigation schemes. Beginning at the chak level, WUAs can eventually permeate all levels of sectoral management. It is also the first step in localized decision-making and cost-recovery that can spiral upward. Simultaneously, scheme-level administration (ID, autonomous board, etc.) can actively reach down to WUAs to enlist them in widening circles of consultancy, participation, decision-making and cost recovery. Successful development of WUAs is likely to depend on:

- (a) Reliable and predictable water supply to the head of each minor; under an agreed operation plan.
- (b) Common economic incentive for farmers to group together to secure tangible and reasonably early gains;
- (c) Equitable participation and operational integrity (periodic elections, defined rights, including safeguards to protect the interests of small farmers, minorities and women, a written constitution and by-laws, and regular meetings of the executive and general body);
- (d) Assistance of NGOs, private consultants, social activists, and local leadership in organizing farmers. Diverse disciplines are required: irrigation engineers, sociologists, management and institutional specialists and trainers; and
- (e) A grass-roots approach, progressively building farmer capabilities and responsibilities.

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<sup>70</sup> "Improving the Productivity and Equity of Irrigation Projects through Integration of Women's Perspectives." M. Mitra, 1990, (Irrigation Sector Review Background Paper).



RECOMMENDATION	RESPONSIBILITY	TIME FRAME
<p>1. <u>FORGE COHERENT WATER RESOURCES POLICY</u>  <u>Reaffirm the National Water Policy</u> and prepare compatible state water policies (GOI Plan funding conditionality)</p> <p>Establish river basin planning commissions (and implementation authorities for multipurpose/state projects)</p> <p>Strengthen data collection and resource analysis</p> <p>Improve central coordination</p> <p>Consider recasting water policy as a "concurrent subject"</p>	<p>GOI coordination/state governments</p> <p>GOI/state governments</p> <p>IDs/MOWR agencies (increasingly by river basin planning commissions) MOWR/other ministries</p> <p>MOWR/Parliament</p>	<p>12 months</p> <p>Initiate immediately</p> <p>Quickly review needs, reflect in next budget</p> <p>Medium term</p> <p>Medium term</p>
<p>2. <u>PRIORITIZE EXPENDITURE AND TIGHTEN FINANCIAL MANAGEMENT</u>  <u>Refocus public investment to prioritize:</u></p> <ul style="list-style-type: none"> <li>-maintenance</li> <li>-water management</li> <li>-private groundwater &amp; micronetwork development (government support to farmers)</li> <li>-project completions (viable)</li> <li>-drainage</li> <li>-(new surface irrigation investments restricted to where regional development needs compel)</li> </ul> <p>Upgrade project preparation and evaluation capabilities. Prepare a pipeline of well-prepared, viable projects.</p> <p>Curb recurrent expenditure growth and financial wastage:</p> <ul style="list-style-type: none"> <li>-halt staff growth</li> <li>-establish management information, expenditure analysis and cost accounting systems (enlist consultant expertise)</li> </ul> <p>Improve cost recovery:</p> <ul style="list-style-type: none"> <li>-establish an annual review and assessment mechanism for water charges</li> <li>-reduce government involvement in collection</li> <li>-remove electric power subsidy</li> <li>-prepare program to implement meter-based electricity pricing</li> </ul> <p>Strengthen central monitoring of state performance and apply central funding conditions regarding:</p> <ul style="list-style-type: none"> <li>-financial discipline (review state financial reports).</li> <li>-full funding of maintenance needs (state maintenance plan, budget and performance review)</li> <li>-investment focus (on priorities)</li> <li>-annual cost recovery reporting</li> </ul>	<p>ID/state government budget process</p> <p>IDs and CWC</p> <p>ID implementation. State finance departments to review</p> <p>Committees appointed by state governments Panchayats/WUAs State government decision Electricity boards</p> <p>Planning and Finance Commissions (CWC technical inputs)</p>	<p>Immediate review and budget application</p> <p>Initiate immediately</p> <p>Immediate application based on quick diagnosis and interim-action plan.</p> <p>Immediate appointment and implementation Medium term Short-term need Medium term</p> <p>Implement for next budget and thereafter</p>

RECOMMENDATION	RESPONSIBILITY	TIME FRAME
<p><b>3. IMPROVE TECHNICAL PERFORMANCE</b></p> <p><u>Ensure maintenance as first priority:</u></p> <ul style="list-style-type: none"> <li>-plan, budget &amp; monitor using an annual ID maintenance plan, budget and performance review</li> <li>-strengthen ID maintenance division</li> <li>-strengthen extension for micronetwork maintenance (by farmers)</li> </ul> <p><u>Implement nationwide water management improvement program:</u></p> <ul style="list-style-type: none"> <li>-prioritize command-by-command diagnostics, operation plans and management and infrastructural improvements</li> <li>-step-up applied research and networking on irrigation technology</li> <li>-selectively pilot more intensive modernizations</li> <li>-emphasize agricultural extension on optimal water usage</li> </ul> <p><u>Upgrade quality control of construction:</u></p> <ul style="list-style-type: none"> <li>-emphasize rigorous on-site management and inspection procedures</li> <li>-improve construction design</li> <li>-tighten contracting procedures</li> <li>-increase accountability (independent auditing)</li> </ul> <p><u>Improve environmental impact:</u></p> <ul style="list-style-type: none"> <li>-prepare national environment policy paper</li> <li>-accelerate/integrate environmental assessment in projects</li> <li>-upgrade environmental monitoring and institutional capabilities</li> </ul> <p><u>Ensure rehabilitation of displaced communities:</u></p> <ul style="list-style-type: none"> <li>-prepare national RAR policy paper</li> <li>-implement good RAR programs in all projects</li> </ul>	<p>IDs (states, GOI to review)</p> <p>IDs</p> <p>IDs, ADs, or CADAs</p> <p>IDs &amp; GOI sponsorship &amp; funding</p> <p>IDs, research centers</p> <p>IDs</p> <p>ADs, WALMIs</p> <p>IDs</p> <p>MOWR/Min. of Environment</p> <p>States &amp; GOI</p> <p>States &amp; GOI</p> <p>GOI</p> <p>IDs</p>	<p>Urgent priority</p> <p>Immediate preparation and priority funding</p> <p>Sustained drive required, initiate immediately</p> <p>12 months</p> <p>All future projects</p> <p>Progressive</p> <p>12 months</p> <p>All future projects</p>
<p><b>4. ENHANCE INSTITUTIONAL CAPABILITIES AND ROLE OF PRIVATE SECTOR</b></p> <p><u>Exploit private sector capabilities:</u></p> <ul style="list-style-type: none"> <li>-increase use of contractors, consultants, universities, research centers and NGOs.</li> <li>-support groundwater and micronetwork investment by farmers, enhance government credit, extension, and support to create WUAs</li> </ul> <p><u>Create autonomous surface irrigation commands:</u></p> <ul style="list-style-type: none"> <li>-identify suitable commands for piloting</li> <li>-devise &amp; implement progressive handover to users (statutes, retention of water charges, WUAs, and management by farmers)</li> </ul> <p><u>Restructure and strengthen IDs</u></p> <ul style="list-style-type: none"> <li>-create functionally specialized divisions</li> <li>-inject non-engineering skills</li> <li>-upgrade staff training</li> <li>-broaden management focus</li> </ul>	<p>IDs</p> <p>IDs (or CADA, AD for micronetworks)</p> <p>IDs</p> <p>Suitable CADAs or other</p> <p>IDs</p>	<p>12 months</p> <p>12 months (initiate)</p> <p>12 months (identify), then implement</p> <p>Initiate immediately, major sustained emphasis</p>



**INDIA**

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